

AM 1934
8
c.1

Boston University
College of Liberal Arts
Library

THE GIFT OF the Author

378.744

B0

AM 1934

g
c.1

P7847

BOSTON UNIVERSITY

GRADUATE SCHOOL

Thesis

HEREDITY IN IDENTICAL TWINS

by

Ella Elizabeth Gaw

(S.B., Boston University, 1929)

submitted in partial fulfilment of the
requirements for the degree of

Master of Arts

1934

HER

p7847

HEREDITY IN IDENTICAL TWINS

Introduction

I Early interest in identical twins

- | | | |
|--------------------------|-------|---|
| 1. "Castor" and "Pollux" | . . . | 1 |
| 2. "Menaechmi" | . . . | 1 |
| 3. "Comedy of Errors" | . . . | 2 |

Embryological Aspect

I Polembryony . . . 3

A. Specific

- | | |
|---|---------|
| 1. Armadillo: Two species
belonging to genus Dasypus | . 3 |
| 2. Cattle | . . . 8 |
| 3. Parasitic Hymenoptera | . . 9 |
| 4. Trout | . . . 9 |

B. Sporadic

- | | |
|--------|----------|
| 1. Man | . . . 10 |
|--------|----------|

II Types of twins in man . . . 10

A. Dizygotic . . . 10

B. Monozygotic . . . 11

C. Conjoined . . . 11

D. Double monsters . . . 12

THE HISTORY OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

OF THE

III. Production of monovular twins

in man . . . 14

Identification

I. Methods

Galton . . . 20

Wilder . . . 20

Dahlberg . . . 21

Siemens . . . 22

Komai . . . 25

Newman . . . 26

Rife . . . 30

Heredity

I. Normal . . . 32

II. Pathological . . . 55

III. Identical triplets in man . . . 71

Summary . . . 74

Digitized by the Internet Archive
in 2013

HEREDITY IN IDENTICAL TWINS

INTRODUCTION

Early interest in identical twins.

Identical twins, now the subject of scientific research, have afforded useful material for the dramatist and novelist from early times. The Heavenly Twins, Castor and Pollux, the sons of Leda according to classical tradition, were the result of the union of Zeus, in the form of a swan, with their mother. One tradition states that Leda brought forth two eggs, from one of which Castor and Pollux were born, and from the other Helen.

The earliest play in which twins appear is the "Menaechmi" of Plautus. The close similarity between the twins, Menaechmus of Epidammus and Menaechmus of Sosicles, who unaware of each other's presence in Epidammus, unwittingly personate each other giving rise to many amusing situations until mutual recognition solves their difficulties at the end of the play, is best described by Messinio, the servant of Menaechmus of Sosicles:

"But I never beheld one person more like another person. Neither water, believe me, is ever

THE HISTORY OF THE

AMERICAN

REPUBLIC

FROM THE FIRST SETTLEMENTS TO THE PRESENT

BY JAMES M. SMITH

VOLUME I

THE FIRST SETTLEMENTS TO THE PRESENT

THE FIRST SETTLEMENTS TO THE PRESENT

THE FIRST SETTLEMENTS TO THE PRESENT

THE FIRST SETTLEMENTS TO THE PRESENT

THE FIRST SETTLEMENTS TO THE PRESENT

THE FIRST SETTLEMENTS TO THE PRESENT

THE FIRST SETTLEMENTS TO THE PRESENT

THE FIRST SETTLEMENTS TO THE PRESENT

THE FIRST SETTLEMENTS TO THE PRESENT

THE FIRST SETTLEMENTS TO THE PRESENT

THE FIRST SETTLEMENTS TO THE PRESENT

THE FIRST SETTLEMENTS TO THE PRESENT

THE FIRST SETTLEMENTS TO THE PRESENT

THE FIRST SETTLEMENTS TO THE PRESENT

THE FIRST SETTLEMENTS TO THE PRESENT

more like to water nor milk to milk, than he is to you and you likewise to him."

In Shakespeare's "Comedy of Errors" two pairs of twin brothers, Antipholus of Ephesus and Antipholus of Syracuse and their two attendants Dromios of Ephesus and Dromios of Syracuse separated while boys meet by chance in Ephesus. So like are they that the duke says:

"These two Antipholuses, these two so like,

And these two Dromios, one in semblance,-"

Shakespeare characterized the two Antipholuses as being different in temperament and intellect. The two Dromios, not so distinctly marked in points of difference, exhibited a different type of humor. Similarly, investigators have discovered that although identical twins show a great degree of resemblance, they also show differences.

and it is not possible to find a single value for the

value of the function at the point

of the function at the point

of the function at the point

of the function at the point

of the function at the point

of the function at the point

of the function at the point

of the

of the function at the point

of the function at the point

of the function at the point

of the function at the point

of the function at the point

of the function at the point

of the function at the point

EMBRYOLOGICAL ASPECT

Polyembryony

Newman (1917) defines polyembryony as the production of plural offspring either sporadically, that is, the occasional production of multiple embryos in a species in which the egg typically differentiates into a single individual, or specifically, that is, the habitual production of multiple embryos in a given species, from a single egg. In a later publication, Newman (1923) defines polyembryony as a reproduction which is non-axiate, being a gross fragmentation of a blastoderm.

Defining twinning as essentially a dichotomy, that is, a division of one primordium into two, Newman (1923) represents the South American armadillo, *Dasypus hybridus*, as producing numerous offspring from a single blastoderm brought about by repeated dichotomies, or in *Dasypus novemcinctus* only two dichotomies. Thus he considers the armadillo as representing true twinning rather than polyembryony.

Hamlett (1933) gives the following historical account of the work which lead to the proof of the hypothesis that armadillos give birth to multiple offspring from a single ovum. The nine-banded armadillo, *Dasypus (Tatusia) novemcinctus*, and *Dasypus hybridus* are the only vertebrates

THE HISTORY OF THE

REIGN OF

CHARLES THE FIRST

BY SAMUEL JOHNSON

IN TWO VOLUMES

LONDON: Printed by J. DODD, in Pall-mall, 1764.

THE HISTORY OF THE

REIGN OF

CHARLES THE FIRST

BY SAMUEL JOHNSON

IN TWO VOLUMES

LONDON: Printed by J. DODD, in Pall-mall, 1764.

THE HISTORY OF THE

REIGN OF

CHARLES THE FIRST

BY SAMUEL JOHNSON

IN TWO VOLUMES

LONDON: Printed by J. DODD, in Pall-mall, 1764.

THE HISTORY OF THE

REIGN OF

CHARLES THE FIRST

BY SAMUEL JOHNSON

IN TWO VOLUMES

LONDON: Printed by J. DODD, in Pall-mall, 1764.

which are known to exhibit specific polyembryony. In 1885, Von Jhering noticed that the females of *Dasyus hybridus* gave birth to several young, all of the same sex. He surmised that they came from a single egg. Later in 1909, definite proof was given the supposition by Fernandez, and in the same year Newman and Patterson published a paper showing the occurrence of a similar phenomenon in *Dasyus novemcinctus*.

In the nine-banded armadillo, four is the typical number of embryos. Hamlett (1933) states that variations from this number are very infrequent:

"In a series of 114 vesicles old enough so that the number of embryos could be determined, one showed 5 embryos and one 3."

Likewise the manner of origin of primordia in the *Dasyus novemcinctus* seems to be invariable. According to the summary of Patterson's description of the process, soon after the hollowing out of the amniotic vesicle, it becomes elliptical, and the floor of the cavity thickens at the two ends, thinning in the center, making primary buds. A further shifting of cells of the primary buds gives rise to secondary buds having a definite position in respect to the original bilateral symmetry of the amniotic vesicle established at the appearance of the primary buds. Then the thickened ectoderm of the four secondary buds becomes the four embryonic shields of the

four embryos.

The armadillo is adapted for a detailed and accurate comparison of the parent and offspring, or of offspring among themselves. The integument is arranged into five armor shields, each shield consisting of well-defined units termed scutes or scales. Each band is made up of fifty to seventy scutes; each consisting of a horny scale, a bony base, and a definitely arranged group of hairs. Newman (1917) considers the whole complex as a unit character. He and his colleagues captured and killed pregnant female armadillos removing and preserving the fetuses and preserving the armatures of the mothers for comparison with those of the fetuses. Armor characters are the same in both male and female armadillos. Based upon a comparison of the total number of scutes in the nine bands in the mother and in the quadruplet offspring, the conclusion was drawn from this intricate and extensive mass of statistical data that both large and small groups of integral variation, such as the aggregate of scutes in an armor shield or a single band, are inherited according to the Mendelian laws of dominance, with only a minor degree of blending, and the dominance is regional and not very often general for a large section of armor.

Applying statistical methods to the above data Newman (1917) found that:

"there was a coefficient of correlation

between mothers and 56 sets of male quadruplets of 0.5522 ± 0.0625 , and for 59 sets of female quadruplets 0.5638 ± 0.0597 .

Making allowance for probability of error, the coefficients of both sexes are practically identical; the coefficient is about 0.5, which is just what we should expect if father and mother contributed equally to the inheritance of these characters."

Using the same statistical methods for determining the heredity between mother and offspring, Newman (1917) found that for the total number of scutes in the banded region "there is a coefficient of correlation of 56 sets of male quadruplets of 0.9294 ± 0.0059 , and for 59 sets of female quadruplets, 0.9129 ± 0.0059 . This degree of correlation is extremely high and it has no parallel among inter-individual correlation coefficients."

Special attention was given to the inheritance of double bands:

"The arrangement of the scutes of the banded region is in general remarkably regular. Each band is typically composed of a single row of scutes. A small percentage of individuals show an irregularity in scute arrangement consisting of parts of

bands that are double, while the rest are single."

Further on Newman (1917) adds:

"It was noted quite early in composing the individuals of polyembryonic sets that sometimes band doublings were repeated with striking faithfulness of position and detail in two or more individuals of a set and were totally absent in others of the same set. Sometimes all four individuals showed these characters, but to a very different extent or in different positions. For example, the doubling might be unilateral in one pair of twins and bilateral in the other, or a character might involve a dozen scutes in some and only one or two in others.

"It appears that there is a close genetic relation between 'scute doubling' where the anomaly affects only one armor unit (an incipient doubling), and 'band doubling', where from two to many units are involved. Some times band doubling in the mother is inherited in the offspring as scute doubling, and vice versa. Quite often the expression of the character may differ within the set of offspring, so that a band doubling or a

scute doubling in the mother may be inherited in some offspring as a band doubling and in others as a scute doubling."

The question has arisen as to whether or not identical twins occur in cattle. Gowen (1922) in a paper compares the records compiled by Lillie using a method to insure a random sample of the general population of cattle twins, with Cole's ratios based on cattle breeders' records of 303 twins, and his own records based on data from the Maine Agricultural Experiment Station and the University of Maine Animal Industry Department.

Table I (Gowen 1922)

Sex Ratios of Twin Births in Cattle					
Authority	Males	Male & Female	Females	P.	P. for 1:2:1 Ratio
A. Cole	43	165	88	AB. .001	.045
B. Lillie	19	24	11	BC. .55	0.29
C. This paper	9	20	8	AC. .25	0.92

In the above table the comparison of the three frequency distributions is made under P. Using the proportion 1:2:1, based on the assumption that identical twins are lacking in cattle, the comparison of the frequency distributions to this proportion are given in the second column of P. for Table I.

"The data of this paper clearly show a distribution of 1:2:1, indicating that

THE UNIVERSITY OF CHICAGO

DEPARTMENT OF THE HISTORY

OF THE UNITED STATES

AND OF THE WORLD

OF THE EAST ASIAN LIBRARY

OF THE UNIVERSITY OF CHICAGO

OF THE EAST ASIAN LIBRARY

OF THE UNIVERSITY OF CHICAGO

OF THE EAST ASIAN LIBRARY

OF THE UNIVERSITY OF CHICAGO

OF THE EAST ASIAN LIBRARY

OF THE UNIVERSITY OF CHICAGO

OF THE EAST ASIAN LIBRARY

OF THE UNIVERSITY OF CHICAGO

OF THE EAST ASIAN LIBRARY

OF THE UNIVERSITY OF CHICAGO

OF THE EAST ASIAN LIBRARY

OF THE UNIVERSITY OF CHICAGO

OF THE EAST ASIAN LIBRARY

OF THE UNIVERSITY OF CHICAGO

OF THE EAST ASIAN LIBRARY

OF THE UNIVERSITY OF CHICAGO

OF THE EAST ASIAN LIBRARY

OF THE UNIVERSITY OF CHICAGO

OF THE EAST ASIAN LIBRARY

OF THE UNIVERSITY OF CHICAGO

OF THE EAST ASIAN LIBRARY

OF THE UNIVERSITY OF CHICAGO

OF THE EAST ASIAN LIBRARY

OF THE UNIVERSITY OF CHICAGO

OF THE EAST ASIAN LIBRARY

identical twins are seldom produced in cattle."

Kronacher's (1932) study of twins in cattle, as reviewed by Newman (1933a), states that the occurrence of monozygotic twins in cattle is suggested statistically by the slight excess of like-sexed twins over unlike-sexed twins and morphologically by the relative frequency of double monsters showing various degrees of separation. Using the same correlation diagnosis as is used for human twins, he found that of thirty five pairs of like-sexed twins five pairs were apparently monozygotic. Two pairs of the five pairs of twins showed remarkable concordance.

We find polyembryony exhibited in other animals as well as mammals. In the parasitic hymenoptera of the genus *Litomastrix*, Newman (1917) says that Silvestri found that a single egg divided very early into a large number of separate primordia, each producing an adult insect. The individuals derived from this egg were always of the same sex.

Among the kinds of fishes in which one-egg twins and double monsters have been described, according to Newman (1923), the trout has proved itself the favorite. In trout separate one-egg twins are believed to arise either from the appearance of two embryonic rudiments on one blastoderm or the presence in the egg of two separate blastoderms. Conjoined twins of the "autosite parasite"

variety occur also in trout.

Sporadic polyembryony as described by Newman (1917) appears in man in the form of monozygotic and conjoined twins.

Types of twins in man

Davenport (1919-20) states that about one per cent of human births are twin births. Hirsch (1930) places the percentage of twin births in the United States a little higher, that is, one twin birth out of every ninety-three, or one individual out of every forty-five or forty-seven is of twin origin.

Twins are of two distinct types, dizygotic being the result of the fertilization of two ova simultaneously or successively; or monozygotic being the result of the complete severance of one fertilized ovum into two halves, each half developing into an independent individual according to Newman (1917, 1923) and many other noted scientists.

Dizygotic twins may be of the same sex or of different sex and resemble each other no more closely than ordinary siblings, whereas monozygotic twins are always of the same sex and are both physically and psychically more similar than dizygotic twins. They are usually considered as having a common yolk-sac, chorion, placenta and frequently a common amnion. (Jordan and Kindred, 1926).

Levin (1931) asks if single-ovum twins can be of

opposite sexes. He bases his interrogation on the case of a blue-eyed man with a segment of brown in the lateral half of his right iris and his twin sister (who had been dead for several years at the time of questioning) who had had a similar segment of brown in the lateral half of her left iris. He considers this unique case of mirror-imaging as suggestive of the single-ovum origin of this pair of twins.

Single-ovum twins have generally been accepted according to Stockard (1921) as belonging to the same series and as resulting from the same causes as conjoined twins or double monsters.

Newman (1917) considers that there are two main types of conjoined twins, one in which the component parts are the equal and symmetrical equivalents of one another; the other, unequal and asymmetrical monsters, one component of which is smaller than and dependent upon the other. The larger more nearly normal individual is called the autosite and the smaller more or less abnormal individual, the parasite.

Just as single-ovum twins are the product of some kind of division of a single ovum, conjoined twins (Newman 1923) are the products of the division of a single egg. They are always of the same sex. They frequently show "situs inversus viscerum", and they are usually joined in symmetrical positions with regard to one another.

Homologous parts of the two systems are always united.

Newman (1923) says that double monsters are the products of a partial twinning process involving a separation of equivalent right and left parts of an originally single embryonic axis. Wilder (1904) expresses practically the same theory:

"Symmetrical Double Monsters are closely related to duplicate twins, and result from a partial instead of a total separation of the first two blastomeres being sufficient to cause a loss of contiguity and hence of relation, over a greater or less extent of surface. The components of monstrous births are the physical duplicates of one another, and will doubtless be found to correspond in regard to palm, sole and finger configuration, as do separate duplicate twins. The double monsters of which we have authentic record are sufficiently numerous and diverse to represent every stage from that of an otherwise normal individual with a doubling of certain of the median parts to that of two complete duplicate twins with a slight connection between them. They may also be arranged to represent several developmental series differing geometrically from one another and corresponding to variations in the place of

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

separation of the first two blastomeres, on in their relative position.

"Unequal double monsters (autosite and parasite) are the result of a secondary fusion of two embryos, owing to a too great contiguity. It is probable that these are at first duplicate twins, the enclosure of which within a common chorion would furnish the crowded conditions necessary for such a fusion."

Newman is opposed to the theory that double monsters are the result of the fusion of two originally complete and separate embryos, whereas Stockard (1921) maintains the theory of the fusion of separate embryos.

"Double monsters", as defined by Hirsch (1930), "are pathological deviants from identical twins where the embryos themselves are joined in some form of union. The embryos may be symmetrically united and developed, or one of the individuals may be arrested in its development."

In advancing an hypothesis for the series of twinning ranging from the very similar separate monovular twins to the autosite and parasite variety of conjoined twins, Newman (1931) ascribes the production of double monsters to a too late twinning to permit the complete separation of the two body halves:

". . . double monsters may result showing profound asymmetry reversal in the

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

median structures of one component and a tendency for the more or less completely bilaterally paired structures of a component to be the same on both sides: for the right hand component has been irreversibly fixed as a right-hand primordium and cannot develop a true left-hand condition. Similarly the left-hand primordium can produce only left-hand expressions of characters. Both sides of the face of the left twin will be left faces."

This may explain why the faces of the conjoined twins are so different.

Production of monovular twins in man.

On the supposition that twins originate always from two ova and that the chances are even as to whether an individual of a pair of twins is to be male or female, Cobb (1915) worked out a hypothetical ratio (1:2:1), that is, we should expect twice as many pairs of girls, or pairs of boys. Cobb compared this hypothetical ratio with the ratio among births of twins from the data she collected. Of the 3,334 twin births which occurred in the states of Connecticut, Maine, and Vermont during the years 1899 to 1912, 1,118 are pairs of boys, 1,193 are boy and girl pairs, and 1,023 pairs of girls. Here is an excess of like-sex pairs of more than 500 pairs of boys and almost 500 pairs of girls making a ratio of 1:1:1. Cobb interpreted these

figures to mean that twins may originate from a single fertilized ovum.

Lenz (1931) calculates that since monovular twins are always of the same sex, whereas diovascular twins are males and females, about one fourth of all pairs of twins must be monovular. The ordinary proportion of twin births to other twins being about 1:80, the proportion of monovular births range from 1:300 to 1:350.

The formation of monovular twins has been studied by Streeter (1919). He says that the earliest stage of development in the human embryos which has been observed is the one described by Miller. This specimen shows the embryo, or embryonic node, consisting of a solid cell mass undergoing cleft formation before opening up the amniotic cavity. He adds further concerning the Miller embryo:

"The embryo and the tissue from which the exocoelom is formed are inclosed by a trophoblastic shell of ectoderm possessing irregular syncytial loops which tend to enclose the large blood lacunae surrounding the ovum, there being as yet no villi."

In the Mateer specimen which Streeter (1919) examined, the primary embryo is in the presomite stage and has only just acquired a primitive groove, whereas the accompanying twin has reached an even lesser degree of development. In this case the embryonic node is

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

...the ... of ...

represented as having subdivided into two masses, that is, as having given off an hypothetical twin. The chances of the secondary bud reaching maturity would depend on how large a share of the original mass is contributed to it. If the twin is as large as the primary embryo, their chances of development in an orderly manner would be equal, and this is presumably the case in most instances in identical twins. In the Mateer specimen the size of the cavity of the yolk-sac has surpassed that of the amnion, a definite body-stalk has formed, and near it are the two vesicles constituting the twin, which as compared with the primary embryo, is considerably retarded in development. Comparing sections through the amniotic vesicle of the twin and through a corresponding region of the primary embryo, it would indicate that the former was essentially normal in form though much retarded in development. The complete detachment of the yolk-sac lends itself to the view that it is abnormal. It is probable that the larger embryo would have gone on to maturity, and the smaller one remaining stationary in the form of two epithelial vesicles, and being entirely overlooked if the pregnancy had not terminated.

Arey (1922a) furnishes direct proof of the monozygotic origin of human monovular twins. He describes two specimens. One specimen consisted of a single chorionic sac which contained twin embryos, each 12.3 mm. long. Distinct

yolk-stalks arise near together from a common yolk-sac and pass to their respective umbilical cords. The second specimen consisted of a single chorion in which there were twin embryos 11.5 mm. and 12 mm. in length. The separate umbilical cord of each one was attached to the chorionic wall, a quadrant's distance apart. One embryo had no yolk-sac, while the other had one adhering to the amnion. Arey sectioned the umbilical cords throughout their lengths to make certain of this.

Gesell (1922) quotes Williams as recognizing that single-ovum twins may be produced in four different ways:

- "1. By fertilization of two polar bodies.
2. By premature separation of one or more blastomeres from a segmenting ovum.
3. By cleavage of the embryonic area.
4. By double gastrulation of the blastodermic vesicle."

Stockard (1921) states that the earliest accomplishments in experimental embryology was the production of two embryos from a single egg. This was done by separating two primary blastomeres so that they were no longer in their usual intimate relation, each then developing independently and producing a complete individual. He says:

"Doubleness in nature is probably due to a modification of a budding process, and double

monsters and actually identical twins, like all other abnormalities, may result from an arrest or inhibition of development."

Arey (1922b) shows that monochorial twins are many times as numerous in the Fallopian tubes as in the uterus. The tubes are a makeshift locale for placentation which is believed to be greatly belated.

Basing his conclusions on the mode of twinning in the armadillos where a quiescent period is known to exist, Newman (1923) formulates the theory that human twinning, diovular or monovular, is due to some retarding factor or factors. He considers the genetic theory of twinning as "fantastic".

The statement that mothers alone determine the tendency to twinning is not supported by facts. Davenport (1919-20) states that of births giving rise to twin repeating mothers, 4.5 per cent are twin births, and of births giving rise to twin-repeating fathers, 4.2 per cent are twin births. These figures are based on 355 and 289 labors respectively. He says that the rate of occurrence of twin production is high, both on the paternal and on the maternal side of such fraternities containing identical twins. The rate is about thirteen per cent in both cases. In summary, he states that the influence of the male is determined by the circumstance that twin production does not depend merely upon double gastrulation but upon some quality

THE FIRST PART OF THE HISTORY OF THE UNITED STATES

FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME

BY JAMES M. SMITH, LL.D.

NEW YORK: PUBLISHED BY J. B. LIPPINCOTT & CO., 15 N. 2ND ST.

1854.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

THE HISTORY OF THE UNITED STATES, FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME, BY JAMES M. SMITH, LL.D.

of the sperm which will result in a high proportion of fertilization of the eggs ovulated, and a small proportion of fertilized eggs containing lethal factors.

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF CHEMISTRY
530 CHICAGO HALL
CHICAGO, ILL. 60637

IDENTIFICATION

Various methods have been devised for identifying monovular twins from dioovular twins. Galton (1892) as quoted by Komai (1928) was the first to recognize the close similarity existing between the friction-ridge patterns of some pairs of like-sex twins. He compared the prints of the fore, middle, and ring fingers of the right hand of thirty-four pairs of twins. He found that the agreement of patterns was so close that he could classify them according to whether or not they showed close agreement, or showed only partial or no agreement.

Wilder (1904) investigated sixteen sets of twins and two sets of triplets. Ten of the sets of twins were identical and one set of triplets was identical. Based on the palm and sole patterns, nine of the sixteen sets are either absolutely identical or with one or two slight differences due to the disposal of one or two ridges at some critical point. These nine pairs of twins are identical in personal appearance. One of the sets of twins although strikingly similar had different palm patterns. He concluded from his study that:

"The influence of the germ-plasm and its mechanism (i.e. the direct control exercised by

THE HISTORY OF THE

REIGN OF KING CHARLES THE FIRST

BY JOHN BURNET

IN TWO VOLUMES

LONDON, Printed by J. Streater, at the Sign of the Gun, in St. Dunstons Church-yard, 1680.

THE SECOND VOLUME

CONTAINING THE HISTORY OF THE

REIGN OF KING CHARLES THE FIRST

FROM THE DEATH OF KING CHARLES THE FIRST

TO THE DEATH OF KING CHARLES THE SECOND

IN TWO VOLUMES

THE SECOND VOLUME

CONTAINING THE HISTORY OF THE

REIGN OF KING CHARLES THE FIRST

FROM THE DEATH OF KING CHARLES THE FIRST

TO THE DEATH OF KING CHARLES THE SECOND

IN TWO VOLUMES

THE SECOND VOLUME

CONTAINING THE HISTORY OF THE

REIGN OF KING CHARLES THE FIRST

FROM THE DEATH OF KING CHARLES THE FIRST

TO THE DEATH OF KING CHARLES THE SECOND

IN TWO VOLUMES

heredity) is exerted upon the friction-skin surfaces only so far as concerns the general configuration, i.e., the main lines, the patterns and other similar features; the individual ridges and their details (minutiae) are apparently under the control of individual mechanical laws to which they are subjected during growth."

Using Wilder's formula for palm and sole patterns and Galton's scheme for finger prints, Reichle (1929a) examined all the twins who came to the Children's Hospital and Dispensary of Cleveland for treatment as patients. He obtained forty pairs of satisfactory prints. Six pairs of prints were of unlike-sex twins. He was unable to obtain a sharp differentiation of the group into monovular and dioovular twins. He concluded that like finger and palm form will lead to fundamental though not detailed similarity in patterns and that "parakinetic factors in utero" will modify both.

Dahlberg (1926) as quoted by Newman (1928a) says:

"The following demands should be satisfied for a diagnosis of monozygotism for a grown-up pair of twins:

1. That the appearance of the twins give an impression of very great resemblance or identity.

2. That during childhood, neighbors, school fellows, etc., have had difficulties in distinguishing them and have sometimes confused them.
3. That the configuration of the ears does not show great dissimilarity.
4. That the finger prints show a certain high degree of similarity.
5. That the anthropological measurements do not show too considerable differences."

The following diagnostic method was proposed by Siemens (1927):

"Method of determining one-egg twins

A. Traits which agree in one-egg twins almost always and almost completely, in two-eggs twins only rarely.

1. Hair color and form
2. Eye color
3. Skin color
4. Downy hair of the body.

B. Traits which vary only within narrow limits, among one-egg twins, and which usually vary more widely among two-egg twins:

5. Freckles (location of)
6. Appearance of blood in the skin (telangiectasis, cutis marmorata acroasphyxia.)
7. Follicular processes (lichen pilaris, acne.)
8. Tongue (furrowed or not) and teeth.

C. Traits in which one-egg twins usually, two-egg twins only rarely show strong resemblance to each other.

9. Form of face (physiognomy)
10. Form of ear
11. Form of hands (and nails)
12. Body build
13. Mental make-up (school standing, character, talent.)
14. Illness and abnormalities.
15. Traits which are the basis of special methods of investigation (finger prints, microscopic comparison of capillaries, refraction of the eyes, blood groups (and so on).

When this method is used twins as a whole fall into well-defined groups: those with almost complete

similarity, and those with numerous quite pronounced dissimilarities."

Komai (1928) says of Siemens' method:

"It has . . . a rather limited application to twins among races in which the hair color and form, eye color, and skin color are subject to only slight variation as, for instance, the Mongolian race."

Using Siemens' method in comparing the results with palm prints and when available with birth membranes, Reichle (1929b) found that in his investigation of thirty-eight pairs of twins there were six cases with a birth membrane in which there was no discrepancy between the identity percentage obtained by use of Siemens' method and the foetal membrane diagnosis. He found in the case of a pair of twins, which he designates pair No. 30, that with a high identity percentage of seventy, they were an unlike-sex pair, hence dioovular.

Three pairs with high general identity percentages show notable discrepancies in the major traits. Twin pair No. 4, who have general identity percentages of sixty-four, have unlike skin color and lanugo distribution. Twin pair No. 24 with a general identity percentage of seventy-seven have skin color and lanugo distribution which varies in minor points. Twin pair No. 8 with a general percentage of seventy-eight have dissimilar irises. The case of twin

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

1870

pair No. 30 is crucial. In this case, the twins with a general identity percentage of seventy show identity in all major traits yet are of unlike sex, and hence diovar. In the entire series of cases, there is a notable absence of the striking similarity between monovular twins which one sees so frequently in adults. He concludes that Siemens' method is satisfactory if applied to a series of cases but not to an individual case.

Komai (1928) uses the following method of diagnosis:

1. Foetal membranes. If each foetus is covered with a common chorion and a common placenta, the twins are monozygotic.
2. Physiognomy and body build. If the degree of facial resemblance is so great as to cause the twins to be mistaken for one another by those who know them best, also if there exists a very close resemblance in body build, the twins are monozygotic.
3. Palm, sole, and finger prints. If the palm, sole and finger prints resemble each other more closely than the prints of different sexed twins, or like-sex twins who are dizygotic, they are monozygotic.

Komai (1928) studied nine sets of palm, sole, and finger prints of like-sex twins and fifty-five sets of palm and finger prints of different-sex twins, and one set of palm and finger prints of male triplets obtained

mainly from among the school children of the city of Kyoto. He supplemented this material by adding to it the collection of Mr. Abonai which included the finger prints of 166 pairs of different-sex twins obtained from among the school children in the city and suburbs of Tokyo, and some are accompanied by palm prints. Komai concluded that the finger, palm, and sole prints of the twins, whose monozygosity is evident from the similarity of physiognomy, body build, and school standing, are more similar than the prints of different-sex pairs of twins, and like-sex twins who are dizygotic. He adds further that certain like-sex twins who are known to have been born with a common placenta and who resemble each other very closely in physiognomy and body build, have dissimilar patterns on more than two pairs of fingers, palms, or soles.

The following criteria for diagnosing identical twins is used by Newman (1928a) and his collaborators:

- "1. They must be strikingly similar in general appearance including various intangible resemblances.
2. They must be essentially identical in hair color, texture, and form.
3. They must have the same shade of eye color and form of iris.
4. They must have the same skin color and texture (complexion) except when one is more tanned than

the other.

5. They must have no marked differences in features; shape of ears; shape, size and arrangement of teeth.

6. They must have hands of the same type and nearly equal in size.

7. The general microscopic character of the papillary ridges in fingers and palms must be essentially the same.

8. There must be stronger cross resemblance than internal resemblance in one or more of the details of finger and palm patterns.

9. The presence of reversed asymmetry in handedness or hair whorl in one twin is confirmatory evidence of monozygosity, but its occasional presence in unlike twins is not to be taken as an indication of monozygosity."

Newman comments that the intensive study of palm and finger patterns is perhaps the best single diagnosis of monozygosity.

In an attempt to test the possibilities of dermatoglyphics on the first forty-two pairs of twins in his collection of a study of their palm prints, Newman (1931) found that thirty-eight of the forty-two pairs could be positively identified, two pairs correctly but with some doubt, and two pairs incorrectly. Then

he says:

"My method of diagnosing twins about whose embryonic membranes we know nothing is a modification of Siemens' method. First of all, I diagnose all opposite-sex pairs without further ado as dizygotic. When I see a same sexed pair, I can tell at a glance in over 90 per cent of cases, whether they are monozygotic or dizygotic. They are either so strikingly similar in countenance, carriage, body build, expression, voice, coloring, etc. that they could hardly be other than monozygotic; or else they are so different in all these respects, or in most of them, that they must be dizygotic. The difficulties are confined to 8 or 10 per cent. These require much more careful handling. They are subjected to the similarity test and this usually succeeds in separating them rather readily. Still there may remain two or three per cent of cases about which there lingers a slight doubt and for which still further data are needed. Here is where dermatoglyphics affords the crucial test. I ask myself the following questions:

1. Are the hands of the two twins of

the same general shape and size?

2. Are the fingers of the same relative length and breadth?

3. Is the general texture of the friction ridges about the same? Are they both coarse, both fine, both medium, or have they both the same general peculiarities of texture?

4. Are any unusual peculiarities of pattern present in the two in which they are more closely similar than would be expected in two genetically unlike?

5. Are there evidences of asymmetry reversal or mirror-imaging, in the main lines or patterns of one of the twins?

6. Finger prints must also be subjected to the same scrutiny and the same questions asked about them as are asked about palm prints."

If the answer to all the above questions is yes, then Newman places the twin pairs in the identical class. He adds that one must remember that there is bimanual asymmetry in palm patterns and the tendency of the bimanual asymmetry to undergo complete or partial reversal in monozygotic twins. Partial reversals tend to obliterate both homolateral and heterolateral

THE HISTORY OF THE

ROYAL SOCIETY OF LONDON

FROM ITS ORIGIN TO THE PRESENT

BY JOHN HENRY DODD

OF THE SOCIETY OF LONDON

IN TWO VOLUMES

VOLUME I

FROM THE ORIGIN OF THE SOCIETY

TO THE PRESENT

BY JOHN HENRY DODD

OF THE SOCIETY OF LONDON

IN TWO VOLUMES

VOLUME I

FROM THE ORIGIN OF THE SOCIETY

TO THE PRESENT

BY JOHN HENRY DODD

OF THE SOCIETY OF LONDON

IN TWO VOLUMES

VOLUME I

FROM THE ORIGIN OF THE SOCIETY

TO THE PRESENT

BY JOHN HENRY DODD

OF THE SOCIETY OF LONDON

IN TWO VOLUMES

VOLUME I

resemblance.

Rife (1933) made intra-pair comparisons of fifty sib pairs and fifteen identical twin pairs in respect to iris pigmentation. He studied the eyes with the Beebe Binocular Loupe. All observations were made in the bright daylight, and members of a pair were examined together. Distribution, hue, and chroma values of the pigmentations were mapped for each pair, the Munsell color chart being used in estimating hue and chroma values. He found in the case of the fifty sib pairs no two individuals having the same iris pigmentation throughout the entire iris. In the ten cases the outer zones were alike and the inner zones were different. In the fifteen pairs of identical twins, the pigmentation and its distribution showed as great a similarity as that observed between the right and left eyes of a single individual. He says that it is a known fact that the right and left eyes of an occasional individual are of quite different coloration, probably due to a somatic mutation; so it is to be expected that an occasional pair of identical twins will show up in which an intra-pair difference in pigmentation occurs. Rife considers that iris pigmentation is a far more reliable criterion for monozygosity than any other criteria. It has the advantage of requiring no specialized training.

Fortuyn (1932) states that the distinguishing of identical and fraternal twins cannot be done at birth for important characters have not yet developed and prenatal conditions are such as to make identical twins at birth more different than fraternal twins probably due to intrauterine conditions and differences in placental circulation.

The best age to test twin resemblance, according to O. v. Verschuer (1928), is from four to six years. Not one or two, but a large number of independent characters should be studied. For the white race, the following characters are especially suitable: color, shape, and implantation of the hair; color of the eyes; color and vascularization of the skin; shape and position of the teeth; shape of the nose, the lips, and the hands; and finally the blood group.

HEREDITY

Normal

Galton (1883) made the first experimental study of twins. He compared a group of thirty-five pairs of very similar twins with a group of twenty pairs of markedly unlike twins. He was led to conclude from the evidence produced by his thirty-five pairs of twins that the only circumstance capable of producing a marked effect on the character of adults, is illness or some accident which causes physical infirmity. Of the twenty pairs of dissimilar twins, he says that the causes conducive to assimilation began to act from the earliest moment of the existence of the twins, when the disposition was most pliant, and they were continuous until the period of adult life.

Handedness according to Newman (1928b) is of two distinct kinds, either genetically determined, or epigenetically determined, the result of twinning. Genetic handedness is transmitted so that any zygote will give rise to a right-handed or left-handed individual. About eighty per cent of single individuals are right-handed, and the remaining sixteen per cent are ambidextrous. The incidence of right- and left-handedness is about what is expected if right-handedness is a dominant Mendelian

College

Letter 1

My dear friend, I have been thinking about you a great deal lately. I hope you are well and happy. I have been thinking about the future and how I want to live. I want to be a good person and to do good deeds. I want to be a good citizen and to be a good neighbor. I want to be a good friend and to be a good lover. I want to be a good parent and to be a good teacher. I want to be a good leader and to be a good follower. I want to be a good person and to be a good citizen. I want to be a good friend and to be a good lover. I want to be a good parent and to be a good teacher. I want to be a good leader and to be a good follower.

Yours truly,

I have been thinking about you a great deal lately. I hope you are well and happy. I have been thinking about the future and how I want to live. I want to be a good person and to do good deeds. I want to be a good citizen and to be a good neighbor. I want to be a good friend and to be a good lover. I want to be a good parent and to be a good teacher. I want to be a good leader and to be a good follower. I want to be a good person and to be a good citizen. I want to be a good friend and to be a good lover. I want to be a good parent and to be a good teacher. I want to be a good leader and to be a good follower.

unit character, and left-handedness is a recessive character. Epigenetic handedness is quite different in origin and heritability. Left-handedness, the result of twinning, being a somatic modification, would not be hereditary but merely an expression of asymmetry reversal due to the development of a whole individual from a half embryo which had become more or less differentiated in the left-handed direction before the separation into twins had taken place.

In only ten pairs of Newman's (1928b) collection of identical twins did he find asymmetry reversal either of left-handedness, counter-clockwise hair whorl, or both, in both twins of a pair. In eight of these pairs, both twins of a pair are left-handed, or both have counter-clockwise hair whorls. Newman assumes that these pairs are genetically left-handed. Two pairs of his twins had one twin of each pair left-handed, and the other twin had a counter-clockwise hair whorl. He adds that these two pairs are also derived from genetically left-handed zygotes.

Siemens (1924), according to Newman (1928b) found in thirty-seven pairs of identical twins, twenty-six cases in which both twins of a pair were right-handed, ten cases in which one twin of a pair was right-handed and the other twin left-handed, and one case where they were both left-handed.

As quoted by Newman (1928b), Weitz (1924) found

that among eighteen pairs of identical twins, seven pairs had one twin left-handed, and the other twin right-handed; ten pairs had both members right-handed; and one pair had both members left-handed.

After examining a group of 212 pairs of twins Lauterbach (1925) concluded:

"The frequency of left-handedness among twins, its occurrence in twin-bearing families, and its apparent relationship to 'situs inversus viscerum', suggest that the fundamental causes of twinning and left-handedness are the same."

Schokking (1931) in his thesis as quoted by Sanders (1932a) from the data he collected, based on the investigation of ninety-one pairs of monovular twins and ninety-five pairs of same-sex diovular twins asserts that left-handedness seems to be to a certain degree dependent on heredity.

Fischer (1931) states that craniometry shows that the heads of monovular twins are very much alike. In the case of twin girls, twenty-three years of age, he secured the following measurements using Martin's method:

1	3	4	6	8	18	21	13
GREATEST LENGTH OF HEAD	GREATEST WIDTH OF HEAD	NARROWEST FRONTAL WIDTH	ZYGOMATIC WIDTH	WIDTH OF LOWER JAW	HEIGHT OF FACE	HEIGHT OF NOSE	WIDTH OF NOSE
I 190	150	107	130	89	106	48	30
II 191	149	107	130	91	106	47	30

¹The numbers before the column-heads are those of Martin's method. Measurements are in millimetres.

The convolutional patterns in the brains of a pair of identical twins were strikingly similar according to Sano as quoted by Davis (1922). The crown whorls of these twins were on opposite sides of the median line.

Hirsch (1930) studied thirty-eight pairs of identical or as he prefers to call them similar twins. The twins were living in the same home with similar social, economic, and educational background. The ages of the twins ranged from the kindergarten to the last year of high school. He found that in regards to six measurements, height, weight, head length, head width, cephalic index, and intelligence quotients, that the thirty-eight pairs of twins average a difference of .4 inches in height, 2.6 pounds in weight, 1.2 mm. in head length, 1.6 mm. in head width, .87 mm. in cephalic index, and 2.3 points in intelligence quotient. He compared these averages with the average difference of dissimilar twins living in similar environments and found that the greater likeness of similar twins is a function of their innate natures.

Weitz is reported by Lenz (1931) as saying that in almost all instances of monovular twins examined by him, the twins were very much alike in respect to psyche, temperament and mental endowments. He writes:

"What a young student of mathematics

says of himself and his twin brother may be regarded as typical. Both of them, (being, by the way, much the most able members of their school form) had up to and including the middle forms, the same reports, that is to say, the same marks, in each subject; when they had got into the higher forms, there were occasional differences between them in different subjects, but the reports taken as a whole were equally good. The strong point in each of them was mathematics, and even within that field they were at first both of them interested in the same problems. For several terms, now, they have both been studying mathematics, but at different universities. That may well explain why, of late, one of them devoted himself more to geometrical and the other to analytical mathematics. Both of them are very musical, and both play the violin. They like the same composers, and even the same compositions. Neither of them, on the other hand, has any taste for literature, whose study does not to either of them seem worth the pains, so that they do not bother about it."

Handwriting is to some extent according to Weitz as quoted by Lenz (1931) an expression of the mental

constitution. He tells us that in the case of mon-ovular twins the handwriting may be so much alike as to be only with difficulty distinguished.

Danforth (1919) says that certain pairs of twins show profound resemblances in both physical and mental traits, while those of other pairs show no such unusual similarity. Monoovular twins would differ from each other in the same respects and to the same degree as the two sides of the body differ in ordinary individuals.

Hirsch (1930) quotes from Thorndike's (1905) study of fifty pairs of twins, that twins between the ages twelve and fourteen years are no more alike than twins between the ages nine and eleven years although they ought to be, if environment were effective in molding the natures of children. The likeness between these fifty pairs who were not all identical pairs, was two or three times as great as for ordinary children of the same ages and sex brought up under similar environment.

A study of learning and growth in identical twins was carried out by Gesell and Thompson (1929). Two twin girls diagnosed as identical were observed from early infancy to eighteen months of age. One twin was trained, and the other one (not trained) was used as a control. The twins were born at the gestation age of eight and a half months. Twin C. weighed five pounds and three ounces, and Twin T. weighed five pounds and six ounces. They were

physically well developed, and to ordinary inspection, equally developed. The mother died soon after their birth, and the twins were sent to a Nursery Home. The twins have enjoyed the same living conditions. The twins showed the following physical correspondence:

1. Hair: blonde, low wave in form, fine texture.
2. Iris color: light blue.
3. Skin: fair, soft and clear with a small identification mole on Twin C's left knee and on Twin T's right temple.
4. Crown whorl: Twin T's clockwise and Twin C's counterclockwise.

Anthropometric measurements revealed detailed correspondence in measurements of girth, diameter, and length of various parts of the body. The differences shown between the right and left side of one twin tends to be slightly greater than the difference between the two right sides of the respective twins, or between their left sides.

Prints of the skin patterns of both hands of the twins were made at the age of eighteen months. A thorough going degree of identity was shown in the configuration and the formulae for the palm patterns.

Their medical history was very similar, which is suggestive of underlying similarity with respect to biochemical and immunological characteristics.

1. The first part of the paper is devoted to a general discussion of the problem.

2. In the second part, we consider the case of a single variable.

3. The third part is devoted to the case of several variables.

4. In the fourth part, we consider the case of a function of several variables.

5. The fifth part is devoted to the case of a function of several variables.

6. In the sixth part, we consider the case of a function of several variables.

7. The seventh part is devoted to the case of a function of several variables.

8. In the eighth part, we consider the case of a function of several variables.

9. The ninth part is devoted to the case of a function of several variables.

10. In the tenth part, we consider the case of a function of several variables.

11. The eleventh part is devoted to the case of a function of several variables.

12. In the twelfth part, we consider the case of a function of several variables.

13. The thirteenth part is devoted to the case of a function of several variables.

14. In the fourteenth part, we consider the case of a function of several variables.

15. The fifteenth part is devoted to the case of a function of several variables.

16. In the sixteenth part, we consider the case of a function of several variables.

17. The seventeenth part is devoted to the case of a function of several variables.

18. In the eighteenth part, we consider the case of a function of several variables.

19. The nineteenth part is devoted to the case of a function of several variables.

20. In the twentieth part, we consider the case of a function of several variables.

21. The twenty-first part is devoted to the case of a function of several variables.

22. In the twenty-second part, we consider the case of a function of several variables.

23. The twenty-third part is devoted to the case of a function of several variables.

The cumulative evidence indicates an essential similarity of behavior equipment and of developmental pattern in these twins. Of the 612 separate comparative ratings which were made, 513 of them indicate identical correspondence, and eighty-two indicate a plus divergence, and seventeen a minus divergence. The general distribution of the ratings supported the clinical judgment that Twin T showed a slight though inconstant superiority over Twin C.

Twin T was trained for six weeks in stair climbing and in cube play. The training session each day lasted for twenty minutes equally divided between cube play and locomotor activity. Then for the last two weeks Twin C was subjected to training in stair climbing which lasted for ten minutes each day. The environment offered no opportunity for either stair climbing or playing with cubes for either twin. At the age of seventy-nine weeks, Twin T climbed with greater alacrity than Twin C. At fifty-six weeks, they had shown about equal speed in stair climbing. Twin T. climbed with spontaneous enjoyment at forty-nine weeks. The conclusion was drawn that early training has slightly hastened the acquisition of skill without decisively or permanently augmenting it.

The clinical record up to the age of forty-four weeks showed highly similar types of emotional behavior, of playfulness, and emotional expressiveness. The

subsequent career and characteristics of Twin C. have suggested rather consistently that there is a personality difference in the twins. Their cube behavior taken as a whole showed a high degree of underlying identity both from the standpoint of time and space values and time and space patterns. When the twins were one year old, they were taken to the Yale-Psycho-Clinic. Their social behavior as attested by their reactions to numerous situations was similar. The conclusion drawn was that although the general outline of behavior was not dissimilar, there was a greater emotional perseveration in Twin C. and a greater amount of dependency, caution or fearsomeness.

Hirsch (1930) quotes from Page (1928) who collected a large amount of material on twins:

"The tendency of identical twins to maintain parallelism of growth should in any case indicate what is determined for the individual at birth, and a comparison of the parallelism of growth in identical twin sets with that in fraternal twin sets should indicate the strength of the factor of birth, since both identical and fraternal sets have probably been subjected to equally similar conditions of environment.

"An examination of the data for the years 1922 to 1926 of nine identical twin sets

are more nearly alike, when all differences are combined than the most similar of the thirteen fraternal sets

"When the nine identical sets of twins are compared with analogous unrelated children in respect to physical and anatomical differences, we have further indication of the powerful influence of the birth factor. But nine fraternal sets of the same show greater differences in length of leg and in measurements which involve length of leg than analogous unrelated children. Weight and anatomic index show like results for fraternal sets."

Gesell (1922) describes the mental and physical correspondence of a pair of identical twin girls which he designates A. and B. At birth they weighed 4.3 and 5.3 pounds respectively. They were born prematurely by Caesarian section thus escaping some of the hazards and strains of birth. At six months A. suddenly rose to a sitting position in her mother's lap. Soon after B. showed the same ability. At eleven months, they had both begun to walk and talk. In October, 1915 at the age of three, they began the study of French, and in less than a year, they were reading elementary English, French, and Esperanto. They began the formal study of arithmetic at the age of six, and in less than

a year, they were solving mentally problems in fractions and percentage. Now at the age of nine years, they are in the seventh grade doing Junior High School work. They are attractive, animated, sociable children, with a bubbling sense of humor. They are popular with their classmates. At the present time, they speak mature English, they speak French fluently, and they have read "Genesis" in Italian and are now speaking a little Italian and have started to learn Russian. They play duets on the piano, but not with rare distinction. They swim, ride horseback, write jingles, and read by the hour. School work does not tax them. The impression made by physique, countenance, demeanor, and conversation is one of complete similarity.

1. Physical correspondence of A. and B.

They show similarity in teeth, skin patterns, birth moles, cranial and carpal bones.

2. Mental and educational correspondence.

The intelligence quotients of A. and B. as shown by the Binet test were A. 183 and B. 183. Qualitatively, as well as quantitatively, the tests revealed a consistent similarity with respect to general alertness, intensity of attention, deliberation, cooperativeness, sense of humor, and emotional reactions. Comparative ratings in regard to quality of responses were attempted in twenty-five of the Binet tests.

In twelve of these our rating was equality, in

thirteen a slight superiority in favor of B., who showed perhaps a little more directness, conciseness, and power of generalization. In Terman's Vocabulary Test of fifty words A. failed on sixteen words and B. on the same words and one additional one.

Carter (1932) summarizes the results of studies of identical twins brought up in essentially similar environments for each pair. In each case the techniques outlined by Bonnevie, Dahlberg, Siemens, Newman, Muller, and others were used in diagnosing the twins as identical.

Case I. Twins: B. and L. Sex : Male. Age: 14 years. This pair belong to the extremely similar class of identical twins. They have the same home, the same school training, and the same friends. They spend nearly all of the twenty-four hours of each day together. They have had the same illnesses at the same time except in one instance when B. had pneumonia. B. and L. obtained similar scores in the Strong Vocational Interest test. Results obtained from the Bernreuter Personality Inventory test showed B. more introverted, less self-sufficient, and less dominant. The 80-item information test showed L. more inclined to overstate his abilities. The difference in scores on the

Masculinity-Femininity test indicated that B. has more of the mental traits associated with masculinity. L's score on the Meier-Seashore Art Judgment test was slightly higher than B.'s, but neither twin shows any particular aptitude for art.

Case II. Twins: D.C. and T.C. Sex: Female. Age: 38 years. Their environment was similar until they were eighteen years old. At the present time, the twins are superficially different in appearance, as D.C. is thirty pounds heavier, and much stronger. There is a great similarity of stable features such as height, form of face, finger print patterns, and color of hair and eyes. D.C. has had two years of high school training whereas T.C. has had only one year. T.C. attended business college for fifteen months and D.C. entered a year later and completed the same course in nine months. T.C. during the last decade has had an environment which offers more social contacts, and more opportunity for cultural development, intellectual advancement, and pursuit of knowledge. Her husband having died seven years after their marriage, she has worked in the Y.W.C.A. for nine years as General Secretary. She has three children while D.C. has seven. When the children were young D.C. took care of them all. The Strong Vocational Interest test showed that the twins have very similar interests. Bernreuter Personality Inventory test showed that D.C.

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

was more self-sufficient, more dominant, and more extroverted. The 80-item information test showed that T.C. has the greater tendency to overstate her knowledge. The Masculinity-Femininity test showed that T.C. has more of the feminine mental traits. The Woodworth-Cady Questionnaire showed D.C. as more stable although the difference is slight. Vocabulary tests showed D.C. slightly superior. These vocabulary scores approach the mean of ninety-one for college freshmen. The Terman group test showed an intelligence quotient difference of twelve points in favor of D.C.

Case III. Twins: I.R. and L.R. Sex: Male. Age: In their sixties. This pair of twins showed very great physical similarity. They have lived in similar environments, had the same amount of schooling, and have done the same kind of professional work all their lives. Each has a wife and daughter. L.R. has an unsympathetic wife and I.R. is happily married. Their disease histories are the same. I.R. has heart trouble at the present time, and L.R. has not been very well for a year. L.R. was the first born and precedes I.R. in reaching various stages of development. These twins are very different in personality. The Strong Vocational Interest test showed that they had many interests in common. L.R. had four interests which I.R. did not have, and I.R. had two interests which L.R. did not have. Masculine-Femininity

test showed I.R. more masculine. The Watson test for fairmindedness showed both men had more prejudices than the younger sets. L.R. had nearly twice as many as I.R. The Meier-Seashore Art Judgment test showed neither had an aptitude for art. The general trend of results from the Stanford Achievement tests indicates that L.R. has poorer powers of observation, less speed of reaction, a poorer memory, less information, and less resistance to fatigue.

Case IV. Twins: D. and V. Sex: Female. Age: 14 years. This is a pair of Siamese girl twins investigated by Dr. Helen L. Koch. In physical traits, they are very similar. D. the right member of the pair is right-handed and V. the left member of the pair is left-handed. D. menstruated one month in advance of her twin and cut her teeth three weeks earlier. D. is slightly larger than V. The results of the Downey and the Kent Rosanoff Free Association tests showed considerable differences. V. has over three times as many individual responses and greatly exceeds the norms. Pressy X-O tests showed an emotional difference. D. is superior in tests of speed of movement. D. is consistently superior in all tests of intelligence and scholastic achievement.

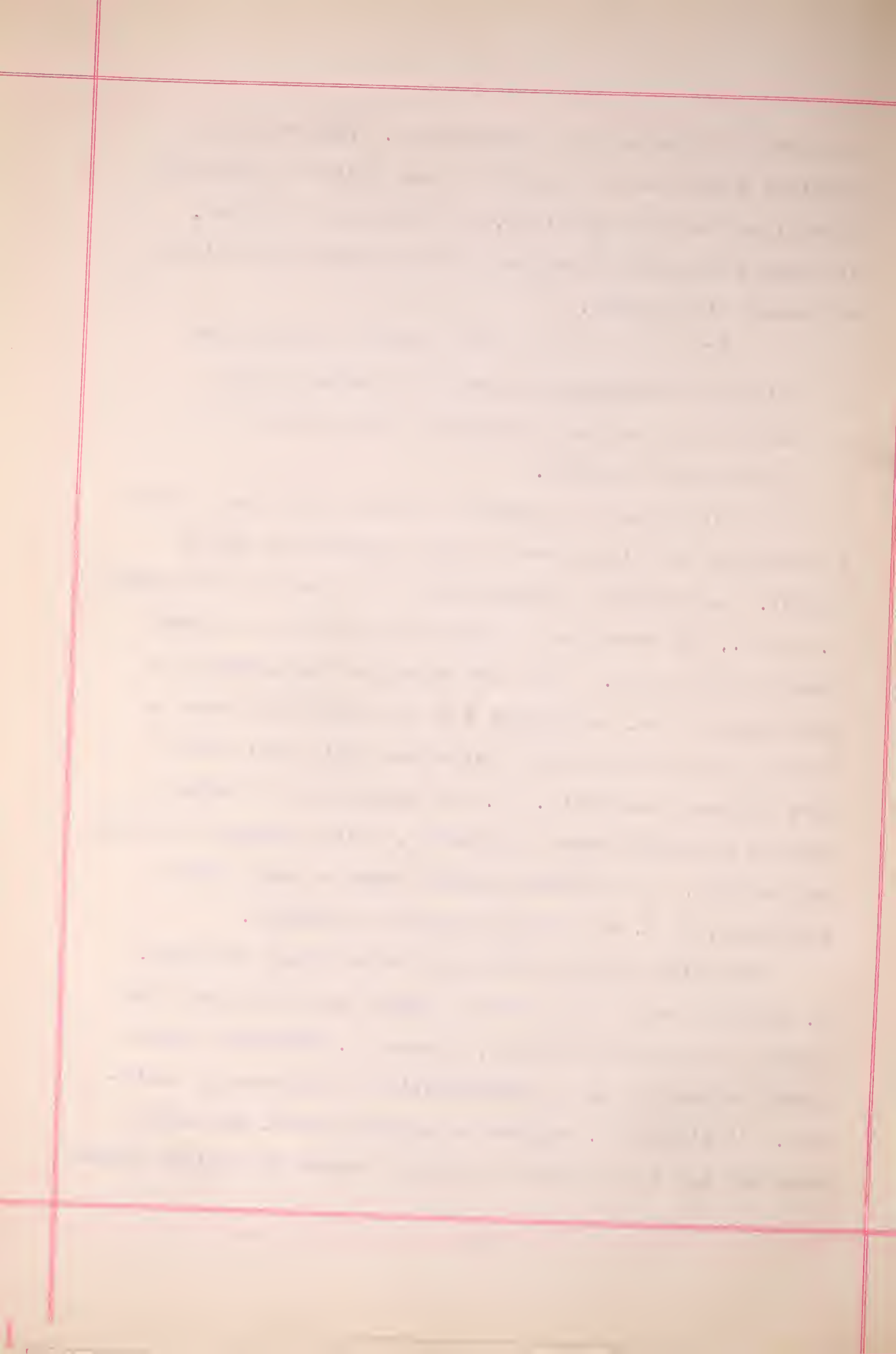
In summary Carter (1932) says that each of the four cases of identical twins reared together exhibits a consistent intra-pair difference in ability as shown

by tests of intellect and achievement. Differences in physical traits seem to exist in some pairs of identical twins from the time of birth, and since this is true, it seems reasonable to assume that the same may be true of mental differences.

"If the right and left cerebral hemispheres differ in functional capacity in normal cases, so may the brains of identical twins differ in functional capacity."

The first case of identical twins reared apart which is found in the literature is that reported by Muller (1925). He studied in great detail the case of twin girls, B. and J., who were born of American parents in a South Dakota mining camp. They were separated permanently at two weeks of age, and except for one additional week in infancy, they did not see each other again until they were eighteen years old. B. was brought up by foster parents who moved about frequently, being engaged in mining and hauling. J.'s foster parents owned a ranch and a roadhouse, so J. as a child saw much of people.

The twins received different educational training. B. received only four years of formal schooling and nine months of business training, whereas J. received a high school education and a summer/session of university training. At fifteen B. engaged in clerical work, and since then she has had an active business career in various places



including France, during and after the war. J. became a teacher. She married at the age of twenty-two, has one child, a boy. She is now teaching again.

B. was less vigorous than J. as a baby. In childhood B. was subject to a disorder of the stomach. She also had measles, mumps, chicken-pox, and typhoid. J. had no special stomach disorder, but had whooping cough, measles, mumps and scarlatina. Both suffered from back-ache, due to congenital shortness of the tendon of Achilles; both had tuberculosis when about eighteen, and both came near to a severe nervous breakdown. J. has had pneumonia.

Physically, they were practically identical. J. had a slightly larger head and cephalic index than B. There was considerable difference between the two hands of each twin. The asymmetries of the twins did not correspond, nor were they mirror images, yet if the right hand of J. had been interchanged with the right hand of B., the twins would have had hands which matched each other about as well as before the exchange.

Mentally both were active, talking at eight months, learning to read at six years, and reading a great deal in after life. Given the Army Alpha intelligence test, and the Otis advanced intelligence test, they scored 156 and 153 respectively in the former, and 64 and 62 in the latter. The higher ratings were made by B., whose opportunities were less ample than those of J.

Newman has undertaken the study of identical twins reared apart to determine to what extent heredity is modified by environment, and whether heredity or environment is the more potent. He planned to study ten cases and has reported eight cases to date.

Case I as reported by Newman (1929a) is the record of twins "A" and "O", who were born in the Chelsea district of London. They were separated at the age of eighteen months, "O" with her foster parents went to live in Ontario, Canada, and "A" stayed in London. With the exception of one visit together when they were ten years old, they were separated about eighteen years. When tested the twins although very similar in physical appearance showed great difference in mental capacity, the difference being nearly three times as great as the average of fifty pairs of identical twins reared together. In temperament they were extremely similar. Newman concluded that environment and training are responsible for bringing about a significantly great divergence in intellectual ability, but that temperament and emotional traits remain the same.

Case II as reported by Newman (1929b) is the record of twins "E" and "G" who are now twenty-seven years old. They were separated when infants and were not known to each other until six years ago. "G" received more formal schooling than "E", as she was graduated from a normal

THE UNIVERSITY OF CHICAGO PRESS

OF THE UNIVERSITY OF CHICAGO PRESS
CHICAGO, ILLINOIS 60607-7090
U.S.A. AND CANADA

THE UNIVERSITY OF CHICAGO PRESS

OF THE UNIVERSITY OF CHICAGO PRESS

CHICAGO, ILLINOIS 60607-7090

U.S.A. AND CANADA

THE UNIVERSITY OF CHICAGO PRESS

OF THE UNIVERSITY OF CHICAGO PRESS

CHICAGO, ILLINOIS 60607-7090

U.S.A. AND CANADA

THE UNIVERSITY OF CHICAGO PRESS

OF THE UNIVERSITY OF CHICAGO PRESS

CHICAGO, ILLINOIS 60607-7090

U.S.A. AND CANADA

THE UNIVERSITY OF CHICAGO PRESS

OF THE UNIVERSITY OF CHICAGO PRESS

CHICAGO, ILLINOIS 60607-7090

U.S.A. AND CANADA

THE UNIVERSITY OF CHICAGO PRESS

OF THE UNIVERSITY OF CHICAGO PRESS

CHICAGO, ILLINOIS 60607-7090

U.S.A. AND CANADA

school and "E" received no more schooling after the fifth grade. In every test of mental capacity "G" was distinctly superior. In contrast with this great difference in mental power stands the fact that in all tests of emotional traits and of temperament, the twins give the impression of being unusually similar. They were practically identical physically.

Case III. This case is of male twins "C" and "O" reported by Newman (1929c). This pair of twins was born in an Illinois village in 1905. They were separated in infancy, one was reared in cities, and the other in small towns. Both twins received a high school education. At the time of this study they were twenty-seven years old, and were practically indistinguishable physically. "C" the city boy, was slightly more intelligent than "O". In temperament, they were as utterly different as two persons chosen at random. In native mental ability the pair seem to be nearly identical. In educational achievement "C" ranks definitely higher than "O".

Case IV. Newman (1932a) reports the case of a pair of identical twins, Mary and Mabel, who are now twenty-nine years old. They were separated at five months and except for visits from time to time have been separated for twenty-eight years. Mabel has always lived on a farm, and Mary has lived mostly in small towns. Mabel stopped school at the end of the grammar school and

Mary went through high school, and has studied music for twenty years. This pair of twins differ equally strongly in all three respects: physically, intellectually, and temperamentally. They show the most pronounced effects of environmental differences of any of the pairs thus far studied.

Case V. The case of identical twins "B" and "D" is studied by Newman (1932b). They are now thirty-eight years old, having been separated for thirty-seven years with the exception of one year when they were twenty. Both twins nearly completed high school. They both married and have four and six children respectively. One twin has had an easy life and the other twin a hard one. There is very little difference between them in intellectual ability. "B" is slightly superior. In temperament and emotional traits, they are very different in some respects, and very similar in others. On the whole, they are more similar than different. In physical condition, there is a very marked difference.

Case VI. Newman (1932c) reports the case of twins Ada and Ida, identical twins, separated at the age of three until they were sixteen. They are now fifty-eight years old. Neither had more than third grade schooling. Both married, Ada at seventeen and Ida at thirty-three. Ada has five children and Ida has four children. Their early life was very similar. Physically, they are very similar.

There is no significant difference between them intellectually. Ada is more dominant, assertive, and militant, whereas Ida is gentle and retiring.

Case VII. The report deals with a pair of identical twins, Richard and Raymond, as reported by Newman (1933b). The twins were born in Indiana. They were separated in infancy, Richard being adopted by a truck farmer, and Raymond being adopted by a well-to-do physician. Both boys have had the same amount of schooling, being in the eighth grade at the time this study was made of them. Their palm prints showed that Richard's left hand was almost identical with Raymond's right hand. Both twins are functionally right-handed and have clockwise hair whorls. The intelligence tests showed them approximately equal, showing less difference than the average difference in fifty pairs of identical twins reared together. Newman classes this pair as being moderately different temperamentally, equal intellectually, and almost equal physically.

Case VIII. Newman (1934) reports the case of a pair of female identical twins, "M" and "R", who were separated at the age of three months. They are now sixteen years old. The health records of the twins are very similar. They are as similar physically as is the average pair of identical twins reared together. Newman states that this is in contrast with the condition found in five of the previous seven cases already reported. The intelligence

tests showed a pronounced difference in intelligence, although unaccompanied by an equal difference in formal schooling. Newman ascribes this great difference to the differences in their informal education. "M" lived among well-educated, cultured, and stimulating persons, and had more extensive and freer association outside the family, whereas "R" and her foster parents were relatively uneducated and unstimulating. The twins are moderately different in their temperament-emotional traits. "M" is much more friendly, talkative, and free from timidity. "R" is very shy.

Hirsch (1930) studied five cases of identical, ("similar"), twins reared apart. He found that in regards to six measurements, height, weight, head length, head width, cephalic index, and intelligence quotients, that the five pairs of twins average a difference of .4 inches in height, 6 pounds in weight, 3.2 mm. in head length, 1 mm. in head width, .75 mm. in cephalic index, and 3.5 points in intelligence quotient. He compared these averages with the average of similar twins living in similar environments and found that for four of the six comparisons, the ratio of differences was almost zero. Only in the cases of weight differences and head-length differences are the ratios of the separated twins differences high. He then contrasted these measurements of five pairs of similar twins reared apart with those of dissimilar twins living in similar

environments and found that in respect to each of the six measurements there was greater average differences among the dissimilar twins than among the separated similar twins.

THE UNIVERSITY OF CHICAGO
LIBRARY
1100 EAST 58TH STREET
CHICAGO, ILL. 60637
TEL. 773-936-5000

Pathological

The study of identical twins in whom diseases and abnormalities occur simultaneously, affecting the same part of the body and to the same degree, may help determine whether or not that particular disease or abnormality is inherited, or to what extent due to environmental causes.

Twinnem (1927) writes on the inheritability of disease:

"The number of diseases classed as hereditary has been diminishing until at present only a few, such as haemophilia and color blindness are so classed. To be hereditary in a true genetical sense a disease must be determined by the actual chromosomal content of the germ cells.---

"There are many diseases which appear to be hereditary, but which are not so in actual fact. That these diseases appear to be inherited may be due to :1, intra-uterine infection; 2, close contact with parents in infancy and childhood; 3, inheritance of constitution which makes the individual particularly susceptible to the development of certain diseases."

Twinnem (1927) gives the following disease histories of nine pairs of identical twins:

"1. J. S. and E. S. Female. Aged 66.

General health of both always good. Both had diphtheria, and marked hypertension.

2. W. L. and J. L. Male. Age of W. L. 49.

J. L. died of lobar pneumonia at the age of 47. W. L. had lobar pneumonia at the age of 42. Otherwise the health of both was good.

3. H. A. and A. A. Female. Age of H. A. 17.

A. A. died at the age of 16 years. At autopsy a large ovarian cyst of unknown pathology was found. H. A. had an ovarian cyst of about the same size on the same side.

4. S. B. and Z. B. Female. Aged 42. General health good. Both had scarlet fever and chicken pox in childhood. Z. B. had appendicitis at the age of 18.

5. R. S. B. and R. B. B. Male. Aged 28.

General health of both always good. Both had measles, mumps, whooping cough, and chicken pox in childhood. Both of these young men are excellent runners, each one having a record of approximately 9:26 for the two mile run.

6. V. R. and E. R. Female. Aged 38. Both had

measles, mumps, and whooping cough in childhood. V. R. had appendicitis at the age of 26.

7. W. O. and Wm. O. Male. Aged 37. General health of both always good. Both had measles, mumps, whooping cough, and chicken pox in childhood.

8. R. B. and L. B. Male. Aged 30. General health of both always good. Both have had whooping cough, measles, and mumps.

9. Mrs. S. and Mrs. R. Aged 27. Both had measles, whooping cough, and chicken pox. Both have had diabetes mellitus for several years. A study of the finger prints of Mrs. S. and Mrs. R. was made by C. C. Carmody, the Bertillon expert of the Detroit Police Department. He found that the general patterns were the same, but there were definite differences in detail."

These cases, which were strikingly alike in temperament and general ability, seem to give definite evidence says Twinem (1927) that there is frequently inherited a general susceptibility to the disease, which is more likely to develop under a favoring environment, than is likely to develop in the average individual without such a hereditary susceptibility. Further he adds that it appears that there is an inherited specific organic susceptibility, not only if the tendency for the disease is inherited and environmental factors being favorable for its development, but also the

disease will affect the same part of the patients body that it involved in its forebears.

Three pairs of apparently identical twins were reported by De Lacey (1931) as haemophilics.

Case 1. One twin died of broncho-pneumonia at the age of two, and up to that time had showed no excessive tendency to bleeding. The other twin brother bruised early, but because of the good care which he received did not bleed externally until he was eleven years old. At that time, he bled to death from a cut on the head.

Case 2. In this case both were bleeders. Ludwig Friedrich is a severe bleeder, a wound on his finger having bled six months. Karl Friedrich at the age of nine months while cutting one of his teeth, a blood vesicle formed and from it, he bled continuously until he eventually died.

Case 3. One twin received an injury to his foot. Generalized bleeding occurred on the following day. The other twin never showed the slightest tendency to bleed unduly.

Lenz (1931) quoting from Weitz says that he found in his study of twins three pairs of monovular twins, in which both twins suffered from suppurative inflammation of the middle ear.

Hereditary predisposition as contributing to the causation of goitre, even in regions where the malady is endemic, is emphasized by the observations of twins made by

Siemens, Pfaundler, and Weitz as quoted by Lenz (1931). From their observations, Lenz says that monovular twins are either both free from goitre or both affected by goitre, and if affected, affected to the same extent.

A case of "Amyotonia Congentia" (Oppenheim's Disease) has been reported by Forbus and Wolf (1930) occurring in monovular twins. The entire life histories as well as clinical histories of these two children are identical. They were born while their parents were in their early forties, the result of the sixth pregnancy. During the pregnancy, the mother withstood an attack of erysipelas. The children were delivered at home without operative interference, the first weighed four pounds and thirteen ounces, the second three pounds and thirteen ounces. The attending physician diagnosed them as single ovum twins, basing his diagnosis on a single placenta. It was noticed at five months that they were not moving their lower extremities. They showed great difficulty in suckling due to choking. In spite of this, they showed a constant gain in weight. Once they were able to raise their heads from the pillow but soon lost this ability. In the hospital they had a maximum elevation of temperature of 103 degrees Fahrenheit. Pathological studies revealed all the lesions which had been identified by other workers on the disease with this disease. Nothing is known of the etiology of this disease. The cause has been associated

The first thing I noticed when I stepped out of the car was the
familiar smell of the city. It was a mix of old and new, of
history and progress. The air was thick with the scent of
coffee from the nearby cafes and the faint aroma of
street food. I took a deep breath, feeling a sense of
belonging. The city was alive, and I was part of it.
I walked down the main street, my eyes taking in the
sights. The buildings were a mix of old and new, of
history and progress. The air was thick with the scent of
coffee from the nearby cafes and the faint aroma of
street food. I took a deep breath, feeling a sense of
belonging. The city was alive, and I was part of it.
I walked down the main street, my eyes taking in the
sights. The buildings were a mix of old and new, of
history and progress. The air was thick with the scent of
coffee from the nearby cafes and the faint aroma of
street food. I took a deep breath, feeling a sense of
belonging. The city was alive, and I was part of it.
I walked down the main street, my eyes taking in the
sights. The buildings were a mix of old and new, of
history and progress. The air was thick with the scent of
coffee from the nearby cafes and the faint aroma of
street food. I took a deep breath, feeling a sense of
belonging. The city was alive, and I was part of it.
I walked down the main street, my eyes taking in the
sights. The buildings were a mix of old and new, of
history and progress. The air was thick with the scent of
coffee from the nearby cafes and the faint aroma of
street food. I took a deep breath, feeling a sense of
belonging. The city was alive, and I was part of it.
I walked down the main street, my eyes taking in the
sights. The buildings were a mix of old and new, of
history and progress. The air was thick with the scent of
coffee from the nearby cafes and the faint aroma of
street food. I took a deep breath, feeling a sense of
belonging. The city was alive, and I was part of it.
I walked down the main street, my eyes taking in the
sights. The buildings were a mix of old and new, of
history and progress. The air was thick with the scent of
coffee from the nearby cafes and the faint aroma of
street food. I took a deep breath, feeling a sense of
belonging. The city was alive, and I was part of it.

with the developing ovum as there is no familial history in any of the reported cases. The authors of this report place the cause as being due to some injury to the developing embryo which localizes especially in the anterior horn of the gray matter of the spinal cord, the condition of the muscles being secondary to this injury.

Susceptibility to tuberculosis may be inherited. Fortuyn (1932) reports the study of Diehl and Verschuer (1930) who investigated nineteen pairs of identical twins and fifty-six pairs of fraternal twins, all seventy-five belonging to families with tuberculosis. These twins are arranged in three groups according to age. In group I there was complete agreement in pathological condition between partners, in group II, there were differences, and in group III, one partner was ill or had died from tuberculosis, whereas the other one was healthy. When age is disregarded, the majority of identical twins is in group I, whereas in groups II and III, fraternal twins are more numerous. This shows, according to this study, that hereditary factors influence the disease.

Schokking (1931) as quoted by Sanders (1932) drew the following conclusions from his study of ninety-one pairs of monovular twins and ninety-five pairs of same sexed fraternal twins:

"Acrocyanosis and cutis marmorata are but little affected by environment. Teleangiectases of the

cheek, interscapulae, and back of the head are preponderatingly determined by heredity. This is also the case with angioma sensilis, while naevi aranei are more determined by external conditions. Acne vulgaris is an hereditary disease (probably depending on two or more genes), which is also the case with the miliae; but these are more variable in expression. Keratosis umbilicis, too, seems to be very much dependent on the hereditary factors; the striae cutis distensae is much more influenced by environment. The naevi are independent of hereditary factors. The occurrence of eczema is based on an idioposition, likewise that of eczema folliculari and of verrucae vulgares. Strabismus convergens appears to be largely independent of hereditary factors. The defraction of the eyes on the other hand is controlled largely by an hereditary component. A distinct tendency towards rickets appears to exist, while for tuberculosis and the acute infectious diseases, the evidence of an hereditary basis is much less conclusive."

The study of identical twins suffering from mental disturbances may determine the heritability of that particular mental character. Marandon de Montyel (1916) according to Murray (1925) observed identical twin sisters. They

the first of these, the fact that the
the second of these, the fact that the
the third of these, the fact that the
the fourth of these, the fact that the
the fifth of these, the fact that the
the sixth of these, the fact that the
the seventh of these, the fact that the
the eighth of these, the fact that the
the ninth of these, the fact that the
the tenth of these, the fact that the
the eleventh of these, the fact that the
the twelfth of these, the fact that the
the thirteenth of these, the fact that the
the fourteenth of these, the fact that the
the fifteenth of these, the fact that the
the sixteenth of these, the fact that the
the seventeenth of these, the fact that the
the eighteenth of these, the fact that the
the nineteenth of these, the fact that the
the twentieth of these, the fact that the
the twenty-first of these, the fact that the
the twenty-second of these, the fact that the
the twenty-third of these, the fact that the
the twenty-fourth of these, the fact that the
the twenty-fifth of these, the fact that the
the twenty-sixth of these, the fact that the
the twenty-seventh of these, the fact that the
the twenty-eighth of these, the fact that the
the twenty-ninth of these, the fact that the
the thirtieth of these, the fact that the
the thirty-first of these, the fact that the
the thirty-second of these, the fact that the
the thirty-third of these, the fact that the
the thirty-fourth of these, the fact that the
the thirty-fifth of these, the fact that the
the thirty-sixth of these, the fact that the
the thirty-seventh of these, the fact that the
the thirty-eighth of these, the fact that the
the thirty-ninth of these, the fact that the
the fortieth of these, the fact that the
the forty-first of these, the fact that the
the forty-second of these, the fact that the
the forty-third of these, the fact that the
the forty-fourth of these, the fact that the
the forty-fifth of these, the fact that the
the forty-sixth of these, the fact that the
the forty-seventh of these, the fact that the
the forty-eighth of these, the fact that the
the forty-ninth of these, the fact that the
the fiftieth of these, the fact that the
the fifty-first of these, the fact that the
the fifty-second of these, the fact that the
the fifty-third of these, the fact that the
the fifty-fourth of these, the fact that the
the fifty-fifth of these, the fact that the
the fifty-sixth of these, the fact that the
the fifty-seventh of these, the fact that the
the fifty-eighth of these, the fact that the
the fifty-ninth of these, the fact that the
the sixtieth of these, the fact that the
the sixty-first of these, the fact that the
the sixty-second of these, the fact that the
the sixty-third of these, the fact that the
the sixty-fourth of these, the fact that the
the sixty-fifth of these, the fact that the
the sixty-sixth of these, the fact that the
the sixty-seventh of these, the fact that the
the sixty-eighth of these, the fact that the
the sixty-ninth of these, the fact that the
the seventieth of these, the fact that the
the seventy-first of these, the fact that the
the seventy-second of these, the fact that the
the seventy-third of these, the fact that the
the seventy-fourth of these, the fact that the
the seventy-fifth of these, the fact that the
the seventy-sixth of these, the fact that the
the seventy-seventh of these, the fact that the
the seventy-eighth of these, the fact that the
the seventy-ninth of these, the fact that the
the eightieth of these, the fact that the
the eighty-first of these, the fact that the
the eighty-second of these, the fact that the
the eighty-third of these, the fact that the
the eighty-fourth of these, the fact that the
the eighty-fifth of these, the fact that the
the eighty-sixth of these, the fact that the
the eighty-seventh of these, the fact that the
the eighty-eighth of these, the fact that the
the eighty-ninth of these, the fact that the
the ninetieth of these, the fact that the
the ninety-first of these, the fact that the
the ninety-second of these, the fact that the
the ninety-third of these, the fact that the
the ninety-fourth of these, the fact that the
the ninety-fifth of these, the fact that the
the ninety-sixth of these, the fact that the
the ninety-seventh of these, the fact that the
the ninety-eighth of these, the fact that the
the ninety-ninth of these, the fact that the
the hundredth of these, the fact that the

suffered from the following maladies simultaneously: colds, intestinal disorder, measles, mumps, and chicken pox. They married, became pregnant at the same time. Each suffered acute mania with identical religious and erotic hallucinations. The children, born within forty-eight hours of each other, were both boys. The mothers recovered rapidly.

Parker (1926) reports eight pairs of identical twins suffering from dementia praecox simultaneously. He ascribes its incidence to a germinal taint, a maladjustment in the egg or sperm cell, or both.

"Science" (1932) publishes an article in which the work of Dr. Aaron J. Rosanoff of the University of Southern California is described. He has collected 404 cases of twins suffering from mental diseases. Of those which were of the same sex, probably of a single ovum origin, 116 pairs had both twins affected and fifteen pairs had but one individual affected. Of 101 pairs of unlike sexed twins, twenty-six pairs had both twins affected and seventy-five pairs had only one member affected. Of those pairs of the same sex, probably not identical, fifty-three pairs had both affected and sixty-seven had only one member affected.

Schulte reports a case of twin brothers, whom he regarded as monovular, as suffering in a like manner from catatonia according to Lenz (1931).

In his thesis, as reviewed by Sanders (1932^a), Legras (1931) records as having examined twenty-four cases of

identical twins suffering from various nervous diseases and four pairs of criminal identical twins. He studied nineteen pairs of fraternal twins as a control. One member of each of these fraternal pairs has been confined to an institution and one member of each pair of five pairs of fraternal twins had been convicted of a criminal offense. The following tables give a summary of his results:

IDENTICAL TWINS (Sanders 1932^a)

Number of cases in which twins were:

	Concordant	Discordant
Schizophrenic psychoses	6	
(Dementia Praecox)		
Manic-depressive psychoses	2	
Idiocy	3	
Epilepsy	2	1
Psychastheny	1	
Suicide	1	
Criminality	4	
Sclerosis multiplex	1	
(sclerose en plaques)		

The following table shows the results of the survey conducted in the year 2000. The data is presented in a tabular format, with the first column representing the different categories of the survey, and the subsequent columns representing the numerical results for each category. The data is as follows:

Category	Result 1	Result 2	Result 3	Result 4
Category A	12	15	18	20
Category B	10	12	14	16
Category C	8	10	12	14
Category D	6	8	10	12
Category E	4	6	8	10
Category F	2	4	6	8
Category G	1	2	3	4
Category H	0	1	2	3

Category A	12	15	18	20
Category B	10	12	14	16
Category C	8	10	12	14
Category D	6	8	10	12
Category E	4	6	8	10
Category F	2	4	6	8
Category G	1	2	3	4
Category H	0	1	2	3

TWO-EGG TWINS

Number of cases in which twins were:

	Concordant	Discordant
Schizophrenic psychoses		9
Degenerative psychoses		1
Melancholic psychoses		1
Epilepsy		1
Hemiathosis post encephalitica		1
Imbecillitas		2
Idioty post encephalitica		1
Monogoloid idiocy		2
Hysteria		1
Criminality		5

Légras concludes that many of the schizophrenic psychoses are determined by heredity. He says that external influences play little part in the history of these cases, except perhaps in affecting the gravity of the symptoms. The manic-depressive psychoses are also little influenced by environmental causes. He adds further that idiocy is determined more by the hereditary constitution, than by such factors as alcoholism and syphilis. Although criminality could not be called a gene determined characteristic, it has a definite hereditary basis. The single case of identical twins both with multiple sclerosis is very suggestive, and Légras expresses the hope that it will lead to further research on the heredity of this condition.

The "Science News Letter" (1934) reports a case of twins, believed to be identical, one of whom developed schizophrenia. Both of these individuals enjoyed the same environment until they were eighteen years old. After graduation from high school, "C. D." went to another city to work with an uncle. He became successful, put himself through a college of osteopathy and is doing comparatively well in a private practice. The other twin "A. B." turned to writing and was not successful in having anything published. He began to have delusions of people preventing him from making good and thought he was being shadowed by detectives. This delusion made life so miserable for him that he went from city to city to escape persecution. Gradually his condition grew worse until he was sent to a hospital for treatment. Dr. Kasanin of the State Hospital of Mental Diseases, Howard, Rhode Island, comments on this case as follows:

" Both these individuals with the same endowment and the same early environmental forces began to show at eighteen an altogether different psychobiological reaction. With the favorable environment for one individual, he becomes a successful, well adjusted man in his community. When the environment becomes bad for the other individual, who is endowed exactly as his brother, he has to find a solution of his failure in a psychosis."

Another letter of interest in the same copy of "Science News Letter" (1934) described the case of two Italian sisters who are identical twins. One of these girls suffered a head injury at birth. The injured twin is slightly duller than her sister and is a year behind her in school. In this case of twins, the normal twin furnishes proof that brain injury at birth is the cause of the mental dullness of her sister, and also in other children suffering from a similar mental condition having been injured at birth.

Mitchell and Downing (1926) report twenty-four cases in which Mongolism occurred in twins. In three of these cases, Mongolism occurred in both twins of the pair. These three pairs of twins were of the same sex, and it is thought that they were identical twins.

R. C. C. (1929) reports five cases of identical twins suffering from Mongolism. He says that the lack of clear-cut cases of identical twins differing in respect to Mongolism suggests an hereditary cause. He also suggests that the condition may be due to some obscure disturbance of the endocrine glands as some endocrine disturbance can be demonstrated in every Mongol.

A new case of Mongolism occurring in a pair of twin girls is reported by Russell (1933). He classes this pair of twin girls as non-identical and feels that this disposes of the genetic basis of Mongolism. He bases their non-identity

on the condition of the foetal membranes. Both Siemens and Verschuer as quoted by Newman (1931) have disproved the accuracy of this type of diagnosis.

Malformations sometimes occur in each member of a pair of twins. Davis (1922) describes a case of congenital tripartite cleft palate accompanied by double harelip in a pair of known identical twins. The only case of harelip in the family is in the case of the father's sister's child who had a cleft palate and harelip, dying at two months of age. The child's father's family history was negative. The twins' mother has no history of uterine disease. The twins had the same color eyes and hair, and the crown whorls were in opposite directions. A complete tripartite cleft palate and double harelip was present in both. In spite of these deformities, the similarity of appearance was striking. In all other respects they were normal and healthy.

In her paper, written for the purpose of pointing out that tumors, both benign and malignant are inherited, Macklin (1932) bases her conclusions on data which she collected. This data show familial histories of a specific type of tumor occurring in a specific organ, and cites the cases of tumors occurring in both members of a pair of identical twins.

Burkard (1922) reports twin sisters, twenty-one years of age, who each developed a fibro adenoma in the left breast

at almost the same time and in the same part of the breast. The structure of the tumor was the same in both. The tumors were removed at the same time. No evidence is given that these twins are monovular.

Cerebellar tumors occurring in a pair of male monovular twins are reported by Leavitt (1928). He based their monozygosity on their striking similarity. At birth they both weighed five and one quarter pounds. Both had dark brown curly hair, dark olive skin, and they were of the same size and stature. They walked when they were twelve months of age and talked at fourteen months. They showed the same physical and emotional characteristics. They were both fond of the same sort of food. They exhibited an extraordinary eagerness to play with fire. In October, 1924, Jules was taken sick with a headache, increasing in severity and frequency, followed by projectile vomiting and disturbance in walking. He was taken to the Children's Hospital in Philadelphia in November. Here, he had several generalized convulsions and died on Christmas Day, 1924, at the age of six and one half years. Ophthalmologic examination revealed bilateral choked disk with an elevation of from three to four diopters above the retinal level. The eyeballs were parallel, and there was no apparent extra-ocular palsies. Postmortem examination revealed a tumor in the vermis of the cerebellum measuring approximately five centimeters in diameter.

In September, 1926, John, the twin brother of Jules, suffered from gradually increasing headaches accompanied by projectile vomiting and disturbance in walking. On Christmas Day he had generalized convulsions lasting several hours. He was unable to walk and became totally blind in the right eye while vision in the left eye was limited to perception of light. He developed skew deviation of the eyeballs and bilateral deafness. The ophthalmologic report of Dr. Warren Reese showed four diopters of choking and three diopters in the left disk, with marked blurring of each. The family would not permit the child to be taken to the hospital. He died in March, 1927. Leavitt (1928) says:

"I believe that the identical occurrence of cerebellar tumors in monozygotic twins may be construed as evidence strongly supporting the 'fetal rest' theory of the development of the neoplastic tissue. There can be little doubt that the twins had cerebellar neoplasms in similar situations, and, as the structure of the tumors examined was composed of embryonic cells, and, as it is believed that monozygotic twins develop as a result of the splitting of a single fertilized ovum, I am of the opinion that both of these tumors were due to 'fetal rest' of embryonic tissue."

1870-1871

1871-1872

1872-1873

1873-1874

1874-1875

1875-1876

1876-1877

1877-1878

1878-1879

1879-1880

1880-1881

1881-1882

1882-1883

1883-1884

1884-1885

1885-1886

1886-1887

1887-1888

1888-1889

1889-1890

1890-1891

1891-1892

1892-1893

Joughin (1928) reports a case of supposedly identical female twins who showed symptoms of an expanding intracranial neoplasm, showing these symptoms synchronously. This pair of twins were the same weight until adult life, had eyes and hair of the same color, and were of the same general mental and emotional make-up. One twin was operated on, on July twelfth 1919 and died twelve hours later. The histological diagnosis was glioma. The other twin was operated on, on the nineteenth of December, 1920 for a subcortical tumor. A second operation was performed on the nineteenth of June, 1921. The histological diagnosis was glioma.

Two cases of similar tumors occurring in identical twin brothers was reported by Champlin (1930). F. K. , unmarried, noted a swelling of the right testicle, the enlargement extended up into the right groin. He sought medical attention, and the testicle with its cord was removed up to the internal ring. The pathologic report was sarcoma. Later, masses were located within the abdomen. Three months after the operation and two years after the onset of the disease the patient died of intracranial involvement. He was twenty-four at the time of death.

The twin brother, J. K. , aged thirty-one and married noted that his right testicle was larger than the other, and also a slight dragging sensation in the right groin. The right testicle with its cord up to the external ring was

THE UNIVERSITY OF CHICAGO PRESS

THE UNIVERSITY OF CHICAGO PRESS
1207 EAST 59TH STREET
CHICAGO, ILLINOIS 60637
U.S.A.
AND
100 Brook Hill Drive
West Nyack, New York 10994
U.S.A.
AND
27 Bedford Row
London WC1R 3EU
ENGLAND
AND
25 Abchurch Lane
London EC4N 3DF
ENGLAND
AND
100 Brook Hill Drive
West Nyack, New York 10994
U.S.A.

THE UNIVERSITY OF CHICAGO PRESS
1207 EAST 59TH STREET
CHICAGO, ILLINOIS 60637
U.S.A.
AND
100 Brook Hill Drive
West Nyack, New York 10994
U.S.A.
AND
27 Bedford Row
London WC1R 3EU
ENGLAND
AND
25 Abchurch Lane
London EC4N 3DF
ENGLAND
AND
100 Brook Hill Drive
West Nyack, New York 10994
U.S.A.

THE UNIVERSITY OF CHICAGO PRESS
1207 EAST 59TH STREET
CHICAGO, ILLINOIS 60637
U.S.A.
AND
100 Brook Hill Drive
West Nyack, New York 10994
U.S.A.
AND
27 Bedford Row
London WC1R 3EU
ENGLAND
AND
25 Abchurch Lane
London EC4N 3DF
ENGLAND
AND
100 Brook Hill Drive
West Nyack, New York 10994
U.S.A.

removed. Recovery was uneventful. The pathologist reported that grossly the testicle was a solid lobulated mass, pale yellow, opaque, of firm consistency and nonvascular. Microscopic examination showed embryonal carcinoma, so-called round cell sarcoma of the testis. Champlin in summary says:

"Similar tumors in identical twins have been reported rarely. Similar disease has been observed in twins more frequently. It is reasonable to suppose that fetal rest tumors especially could occur in both uniovular twins. The identical twins presented here both developed sarcoma of the right testicle, fatal in one on account of delay in treatment and in the other apparently cured by early removal."

Identical Triplets in Man

Identical triplets as well as identical twins add to our knowledge of the influence of heredity. Clarke and Revell (1930) studied two cases of identical triplets.

Case I. Triplets: A., E., and G. Sex: Male. Age: 9 years. At birth each weighed within an ounce of five pounds. The attending physician reported one placenta to which the three umbilical cords were attached. A. is right-handed, and E. and G. are left-handed. All three have a clockwise

1891
The first of the year was a very successful one for the
company. The sales were up to the mark and the
profits were also good. The management was very
satisfied with the results and the future was
bright.

1892
The second year was also a very successful one for the
company. The sales were up to the mark and the
profits were also good. The management was very
satisfied with the results and the future was
bright.

1893
The third year was also a very successful one for the
company. The sales were up to the mark and the
profits were also good. The management was very
satisfied with the results and the future was
bright.

hair whorl. Intelligence tests showed all three very similar in mental ability.

Case II. Triplets: James, Robert, and William. Sex: Male. Age: 17 months. All three resemble each other very closely, but are readily identified by their family. There is complete agreement in friction skin patterns among the triplets. Close similarity was found in such physical characters as height, weight, hair and eye characters.

Sanders (1932b) reports two cases of triplets. One set of triplets show an almost absolute similarity of bodily characteristics as well as mental qualities. The other set show bodily and mental similarity.

A detailed study of a set of identical triplets was made by Sontag and Nelson (1933). The birth membranes of this set showed a single placenta and two chorions. There was no evidence of a fusion of two placentae. Hair color, form, eye color, skin color, downy hair of the body as well as the majority of other physical traits show a striking similarity. Palm and finger prints showed marked similarities, palm prints bearing a closer resemblance than the finger prints. Their mental characteristics were very similar. Their growth and nutrition reactions were alike.

What might be termed a case of double identical twins is reported by Clark (1932). Supposedly monozygotic quadruplets (baby girls) were born in Michigan, May 19,

1930. The close similarity of the four babies in friction skin patterns and other physical characters render it probable that they are identical.

THE UNIVERSITY OF CHICAGO
DIVISION OF THE PHYSICAL SCIENCES
DEPARTMENT OF CHEMISTRY
5301 S. DICKINSON DRIVE
CHICAGO, ILL. 60637

SUMMARY

In all animals exhibiting polyembryony, the individuals are derived from a single egg and are of the same sex. From this fact, we are led to conclude that sex is determined in the undeveloped egg.

The armadillo, whether representing true twinning as suggested by Newman, or polyembryony, in the regularity of its armor bands is a good subject for the study of inherited characters. From the study of the inheritance of the bands and scutes of the armor shields, it seems evident that the aggregate of scutes in an armor shield are inherited according to Mendelian laws of dominance. It was noted in comparing individuals of a polyembryonic set, that sometimes band doublings are repeated with striking faithfulness of position and detail in two or more members of the set and totally absent in others. The expression of the character may differ within the set of offspring.

One per cent of human births are twin births or one individual out of every forty-five or seven is of twin origin. These twin births fall into two classes consisting of monovular or diovascular twins. The monovular twins are always of the same sex and the product of a single fertilized ovum, whereas the diovascular twins may be of different sex and the product of two fertilized ova.

Single-ovum twins result from the same causes as conjoined twins and double monsters, being the product of the division of a single ovum. Double monsters may be due to a partial twinning process, or, as suggested by Stockard, the result of the fusion of two embryos. Newman opposes this theory and credits the phenomenon to a too late twinning to bring about complete separation into independent individuals.

The production of monovular twins in man is suggested by the excess of like-sexed pairs. Arey gave us proof of the incidence of monovular twins in man in his study of early embryos. He showed that the twin-bearing fertilized ovum was more frequently implanted in the Fallopian tubes than in the uterus.

The evidence of the rate of occurrence of twin production being high both on the paternal and maternal side of twin-bearing families points to a genetic factor determining the production of identical twins rather than a retarding factor. The influence of the male is determined by the circumstance that twin production does not depend merely on double gastrulation, but upon some quality of the sperm which results in a high proportion of fertilization of the eggs ovulated and a small proportion of fertilized eggs containing lethal factors.

The problem of determining to what class of twins a pair

The first part of the paper discusses the importance of the study of the history of the English language. It is argued that the study of the history of the English language is not only a matter of historical interest, but also a matter of practical importance. The study of the history of the English language is essential for a full understanding of the English language in its present state. The paper then discusses the various factors which have influenced the development of the English language, and the various stages of its development. The paper concludes by stating that the study of the history of the English language is a task of great importance, and one which should be undertaken by all who are interested in the English language.

The second part of the paper discusses the various factors which have influenced the development of the English language. It is argued that the study of the history of the English language is not only a matter of historical interest, but also a matter of practical importance. The study of the history of the English language is essential for a full understanding of the English language in its present state. The paper then discusses the various factors which have influenced the development of the English language, and the various stages of its development. The paper concludes by stating that the study of the history of the English language is a task of great importance, and one which should be undertaken by all who are interested in the English language.

The third part of the paper discusses the various stages of the development of the English language. It is argued that the study of the history of the English language is not only a matter of historical interest, but also a matter of practical importance. The study of the history of the English language is essential for a full understanding of the English language in its present state. The paper then discusses the various factors which have influenced the development of the English language, and the various stages of its development. The paper concludes by stating that the study of the history of the English language is a task of great importance, and one which should be undertaken by all who are interested in the English language.

The fourth part of the paper discusses the various stages of the development of the English language. It is argued that the study of the history of the English language is not only a matter of historical interest, but also a matter of practical importance. The study of the history of the English language is essential for a full understanding of the English language in its present state. The paper then discusses the various factors which have influenced the development of the English language, and the various stages of its development. The paper concludes by stating that the study of the history of the English language is a task of great importance, and one which should be undertaken by all who are interested in the English language.

belongs necessitated a method of diagnosis. Foetal membrane diagnosis does not constitute an infallible criterion. Although there is a more marked similarity in the palm, sole, and finger patterns between members of a pair of identical twins than between siblings, great differences are exhibited. Asymmetry reversal tends to obscure similarities. Siemens' method is restricted to use in diagnosing twins of the white race where there is wide probability of variance in such traits as color of the hair, eyes, and skin. Identity of iris pigmentation is suggested as the best means of distinguishing monovular twins from dioovular twins. Occasionally, a pair of identical twins will exhibit intra-pair differences in iris pigmentation just as some individuals are known to have one brown eye and one blue eye. This method has the advantage of requiring no specialized training.

Identical twins cannot be determined at birth with any degree of certainty as prenatal conditions tend to make identical twins more different than fraternal twins. The best age to determine monozygosity is from four to six years. One should then base one's diagnosis on a large number of independent characters.

The study of identical twins reveals normal and pathological conditions attributed to germinal heredity. Monovular twins are very much alike in psyche, temperament,

and mental endowments. Twins are no more alike when older than when younger, and they should be if environment were effective in moulding their characters. The tendency for identical twins to maintain parallelism of growth indicates that it is determined for the individual at birth, as fraternal twins differ even if subjected to the same environmental conditions. Similar twins tend to converge with age; dissimilar twins grow more unlike.

Monovular twins reared together show differences in physical traits existing from birth in some pairs, so we may conclude that in some cases a difference in mentality will also occur.

The study by Newman of eight cases of identical twins reared apart shows that environment is responsible in some cases of bringing about divergence in intellectual ability, and that temperament and emotional traits tend to remain the same. On the other hand, one pair of twins in this study, one twin of which enjoyed liberal educational opportunities whereas the other twin received only a meager schooling, stood equally high in the intelligence tests. One is led to ask why these differences occur in identical twins.

The study of identical twins in whom diseases and abnormalities occur simultaneously affecting the same part of the body and to the same degree shows that there must be some underlying genetic factor as a causation of that

particular malady. Data showing children's diseases, haemophilia, goitre (whether or not in regions endemic to the malady), and diabetes mellitus occurring in each member of a pair of identical twins point to the conclusion that some hereditary factor is concerned.

Mental diseases, such as dementia praecox and mongolism, occurring in both members of a pair of identical twins also suggest a germinal taint.

The appearance of the same type of tumors in exactly the same organ leads to the consideration that there is an inherited tendency toward undue proliferation of certain tissues.

Woods (1919) says:

"The great lesson derived from the records of identical twins is that the ordinary differences within the uterus of the mother and the ordinary differences within the home life and school life and even adult life are not of sufficient force to modify greatly the control of the chromosomes."

BIBLIOGRAPHY

Arey, Leslie B. (1922a)

"Direct Proof of the Monozygotic Origin of Human Identical Twins". The Anatomical Record. Vol. XXIII No. 4 pp. 245-248.

Arey, Leslie B. (1922b)

"Chorionic Fusion and Augmented Twinning in the Human Tube" The Anatomical Record Vol. XXIII No. 4 pp. 253-261.

Burkard, H. (1922)

"Tumors in Twins" Journal of the American Medical Association. Vol. 78 p. 1672.

Carter, Harold D. (1932)

"Identical Twins Reared Together." Journal of Heredity. Vol. 23 No. 2 pp. 53-66.

Champlin, Howard W. (1930)

"Similar Tumors of Testis Occuring in IdenticalTwins." The Journal of the American Medical Association. Vol. 95 No. 2 pp. 96-97.

Clarke, Alfred E. (1932)

"Identical Quadruplets" Journal of Heredity Vol. 23 No. 7 pp. 257-259.

Introduction

The purpose of this study is to investigate the effects of various factors on the growth of a certain plant species.

The study was conducted in a controlled environment, where the growth of the plant was monitored over a period of six months.

The factors studied were light intensity, temperature, and water availability. The results of the study are presented in the following sections.

The first section discusses the methodology used in the study.

The second section presents the results of the study.

The third section discusses the implications of the study for future research.

The fourth section concludes the study.

The fifth section discusses the limitations of the study.

The sixth section discusses the future research.

The seventh section discusses the conclusions of the study.

The eighth section discusses the implications of the study.

The ninth section discusses the future research.

The tenth section discusses the conclusions of the study.

The eleventh section discusses the implications of the study.

The twelfth section discusses the future research.

The thirteenth section discusses the conclusions of the study.

The fourteenth section discusses the implications of the study.

The fifteenth section discusses the future research.

The sixteenth section discusses the conclusions of the study.

The seventeenth section discusses the implications of the study.

The eighteenth section discusses the future research.

Clarke, Alfred E. and Revell, Daniel G. (1930)

"Monozygotic Triplets in Man." Journal of Heredity
Vol. 21 No. 4 pp. 147-156.

Cobb, Margaret V. (1915)

"Evidence Bearing on the Origin of Human Twins From a
Single Ovum" Science Vol. 41 No. 1057 pp. 501-502.

Danforth, C. H. (1919)

"Resemblance and Difference in Twins." Journal of
Heredity. Vol. 10 No. 9 pp. 399-409.

Davenport, C. B. (1919-20)

"Heredity of Twin Births" Proceedings of the Society
For Experimental Biology and Medicine. Vol. 17 pp. 75-77.

Davis, Albert D. (1922)

"Tripartite Cleft Palate and Double Harelip in
'Identical Twins '". Surgery, Gynecology and
Obstetrics. Vol. 35 No. 5 pp. 586-599.

De Lacey, M. (1931)

"Haemophilia in a Twin" Lancet Vol. 221 pp. 1074-1075.

Fischer, Eugen (1931)

"Human Heredity" by Erwin Baur, Eugen Fischer, and
Fritz Lenz. The Macmillan Company, New York. Original
title: "Menschliche Erblchkeitslehre " 3rd edition
published by J. F. Lehmanns, Verlag, Munich, 1927.

1. The first part of the paper is devoted to a general discussion of the problem of the existence of solutions of the system of equations

in the case of a linear system of equations with constant coefficients. It is shown that the system has a solution if and only if the determinant of the system is not equal to zero.

2. In the second part of the paper, the problem of the existence of solutions of the system of equations is considered in the case of a nonlinear system of equations with variable coefficients.

3. In the third part of the paper, the problem of the existence of solutions of the system of equations is considered in the case of a nonlinear system of equations with constant coefficients.

4. In the fourth part of the paper, the problem of the existence of solutions of the system of equations is considered in the case of a nonlinear system of equations with variable coefficients.

5. In the fifth part of the paper, the problem of the existence of solutions of the system of equations is considered in the case of a nonlinear system of equations with constant coefficients.

6. In the sixth part of the paper, the problem of the existence of solutions of the system of equations is considered in the case of a nonlinear system of equations with variable coefficients.

7. In the seventh part of the paper, the problem of the existence of solutions of the system of equations is considered in the case of a nonlinear system of equations with constant coefficients.

Forbus, Wiley D. and Wolf, Fred S. (1930)

"'Amyotonia Congentia'" (Oppenheim's Disease) in
Identical Twins." The Johns Hopkins Hospital Bulletin
Vol. 47 No. 6 pp.309-322.

Fortuyn, Dr. A. B. Droogleever, (1932)

"Modern Research on Human Twins." The Quarterly
Review of Biology Vol. 7 No. 3 pp. 298-306.

Galton, Francis (1883)

"Twins, Their History as a Criterion of the Relative
Powers of Nature Over Nurture." "Little Masterpieces
of Science." edited by George Iles pp. 63-77.

Gesell, Arnold (1922)

"Mental and Physical Correspondence in Twins."
Scientific Monthly Vol.14 pp. 305-331.

Gesell, Arnold and Thompson, Helen (1929)

"Learning and Growth in Identical Twins." Genetic
Psychology Monograph Vol. 6 No. 1

Gowen, John W. (1922)

"Identical Twins in Cattle?" Biological Bulletin
Vol. 42 No. 1 pp.1-6

Hamlett, G. W.D. (1933)

"Polyembryony in the Armadillo: Genetic or Physiological?"
The Quarterly Review of Biology Vol. 8 No. 3 pp. 348-358.

Hirsch, Nathaniel D. Mttron (1930)

"Twins: Heredity and Environment." Harvard University
Press, Cambridge, Massachusetts

Joughin, J. L. (1928)

"Coincident Tumor of the Brain" Archives of Neurology and Psychiatry Vol. 19 pp. 948-949.

Jordan, Harvey Ernest, and Kindred, James Ernest (1926)

"A Textbook of Embrology" D. Appelton and Company
New York pp. 524-525.

Komai, Taku (1928)

"Criteria for Distinguishing Identical and Fraternal Twins " The Quarterly Review of Biology
Vol. 3 No. 3 pp. 408-418.

Lauterbach, C. E. (1925)

"Studies in Twin Resemblance" Genetics Vol. 10
No. 6 pp. 525-568.

Lenz, Fritz (1931)

"Human Heredity" by Erwin Baur, Eugen Fischer,
and Fritz Lenz. The Macmillan Company, New York.
Original title: "Menschliche Erblchkeitslehre"
3rd edition published by J. F. Lehmanns, Verlag
Munich 1927.

Lewin, Max (1931)

"Can Single-ovum Twins be of Opposite Sexes?"
Journal of Heredity Vol. 22 No. 1 pp. 17-19.

Macklin, Madge, Thurlow (1932)

"Hereditary Factors in Human Neoplasms" The Quarterly Review of Biology Vol. 7 No. 3 pp. 255-279.

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

1991, 2, 1, 1991

Mitchell, A. Graeme, and Downing, Harold F. (1926)

"Mongolian Idiocy in Twins" American Journal of the Medical Sciences. Vol. 172 pp. 866-872.

Muller, H. J. (1925)

"Mental Traits and Heredity" Journal of Heredity
Vol. 16 No. 12 pp. 433-448.

Murray, George R. (1925)

"A Study of Twins in Health and Disease" The Lancet
Vol. 208 Vol. 1 for 1925 pp. 529-532.

Newman, Horatio Hackett (1917)

"The Biology of Twins (Mammals)"

The University of Chicago Press, Chicago, Illinois.

Newman, Horatio Hackett (1923)

"The Physiology of Twinning"

The University of Chicago Press, Chicago, Illinois.

Newman, H. H. (1928_a)

"Methods of Diagnosing Monozygotic and Dizygotic Twins"
Biological Bulletin Vol. 55 pp. 283-297.

Newman, H. H. (1928_b)

"Studies of Human Twins: II Asymmetry Reversal
of Mirror-Imaging in Identical Twins"

Biological Bulletin Vol. 55 pp. 298-315.

Newman, H. H. (1929a)

"Mental and Physical Traits of Identical Twins
Reared Apart."

Journal of Heredity Vol. 20 No. 2 pp. 49-64,

Newman, H. H. (1929b)

"Mental and Physical Traits of Identical Twins
Reared Apart."

Journal of Heredity Vol. 20 No. 3. pp 97-104.

Newman, H. H. (1929c)

"Mental and Physical Traits of Identical
Twins Reared Apart."

Journal of Heredity Vol. 20 No. 4 pp. 153-166

Newman, H. H. (1931)

"Palm-Print Patterns in Twins"

Journal of Heredity Vol. 22 No. 2 pp. 41-49.

Newman, H. H. (1932a)

"Mental and Physical Traits of Identical Twins
Reared Apart."

Journal of Heredity Vol. 23 No. 1 pp. 3-18.

Newman, H. H. (1932b)

"Mental and Physical Traits of Identical Twins
Reared Apart."

Journal of Heredity Vol. 23 No. 8 pp. 297-304.

Newman, H. H. (1932c)

"Mental and Physical Traits of Identical Twins
Reared Apart."

Journal of Heredity Vol. 23 No. 9 pp. 369-377.

Newman, H. H. (1933a)

"Twins in Cattle."

Zwillingforschung Beim Rind, by C. Kronacher (1932)

Verlag von Paul Parey in Berlin S. W. 11.

Journal of Heredity Vol. 24 No. 6 pp. 229-230.

Newman, H. H. (1933b)

"Mental and Physical Traits of Identical Twins
Reared Apart."

Journal of Heredity Vol. 24 No. 5 pp. 209-214.

Newman, H. H. (1934)

"Mental and Physical Traits of Identical Twins
Reared Apart."

Journal of Heredity Vol. 25 No. 2 pp 55-60.

Parker, G. H. (1926)

"Twins with Dementia Praecox."

Journal of Heredity Vol. 17 No. 4 pp. 137-142.

Reichle, Herbert S. (1929a)

"The Diagnosis of the Type of Twinning."

Biological Bulletin Vol. 56 No. 3 pp. 164-176.

Reichle, Herbert S. (1929b)

"The Diagnosis of Monozygotic Twinning: II Clinical Aspects."

Biological Bulletin Vol. 56 No. 5 pp. 313-326.

Rife, D. Cecil (1933)

"Genetic Studies of Monozygotic Twins: II Finger-patterns and Eye-color as Criteria of Monozygosity."

Journal of Heredity Vol. 24 No. 10 pp. 407-414.

R. C. C. (1929)

"Mongolism in Twins."

Journal of Heredity Vol. 20 No. 2 pp. 64-65.

Russell, P. M. G. (1933)

"Mongolian Twins."

The Lancet (April 15) Vol. 1 pp. 802-803.

Sanders, J. (1932a)

"Twin Research in Holland."

Journal of Heredity Vol. 23 No. 12 pp. 499-502.

Sanders, J. (1932b)

"Similarities in Triplets."

Journal of Heredity Vol. 23 No. 6 pp. 225-234.

Science (1932)

"Mental Disease in Identical Twins."

Science Vol. 1952 (May 27) p. 12.

Science News Letter (1934)

"Only One of Identical Twins Attacked by Mental Disease."

(Feb. 24) p. 116.

"Twins Prove Brain Injury at Birth Affects Mentality."

(Feb. 24) p. 119.

Stockard, Charles R. (1921)

"Developmental Rate and Structural Expression:
An Experimental Study of Twins, 'Double Monsters'
and Single Deformities and the Interaction
among Embryonic Organs during their Origin
and Development."

American Journal of Anatomy Vol. 28 No. 2 pp. 115-262

Streeter, George L. (1919)

"Formation of Single Ovum Twins."

Bulletin of The Johns Hopkins Hospital

Vol. 30 No. 342 pp. 235-238.

Sontag, L. W. and Nelson, V. L. (1933)

"A Study of Identical Triplets: Part I
Comparison of Physical and Mental Traits of
a Set of Monozygotic Dichorionic Triplets."

Journal of Heredity Vol. 24 No. 12 pp. 473-480.

Twinem, Francis Patton (1927)

"Identical Twins and the Problem of Heredity."

The New York State Journal of Medicine

Vol. 27 No. 21 pp. 1192-1193.

THE UNIVERSITY OF CHICAGO

THE DIVISION OF THE PHYSICAL SCIENCES

PHYSICS DEPARTMENT

PHYSICS 309

LECTURE 1: INTRODUCTION TO QUANTUM MECHANICS

WEDNESDAY, JANUARY 10, 2018

LECTURER: DR. J. J. HALL

LECTURE 2: THE SCHRÖDINGER EQUATION

THURSDAY, JANUARY 11, 2018

LECTURER: DR. J. J. HALL

LECTURE 3: ANGULAR MOMENTUM

FRIDAY, JANUARY 12, 2018

LECTURE 4: THE HYDROGEN ATOM

MONDAY, JANUARY 15, 2018

LECTURER: DR. J. J. HALL

LECTURE 5: PERTURBATION THEORY

TUESDAY, JANUARY 16, 2018

LECTURER: DR. J. J. HALL

LECTURE 6: SCATTERING THEORY

WEDNESDAY, JANUARY 17, 2018

LECTURER: DR. J. J. HALL

LECTURE 7: RELATIVITY AND QUANTUM MECHANICS

THURSDAY, JANUARY 18, 2018

LECTURER: DR. J. J. HALL

LECTURE 8: QUANTUM FIELD THEORY

FRIDAY, JANUARY 19, 2018

v. Verschuer, O. (1928)

"Die Ähnlichkeitsdiagnose der Eineiigkeit
von Zwillingen."

Anthropologischer Anzeiger Vol. 5 No. 3 pp. 244-248.

Wilder, Harris Hawthorne (1904)

"Duplicate Twins and Double Monsters."

American Journal of Anatomy Vol. 3 No. 4 pp. 387-472.

Woods, Frederick Adams (1919)

"Twins Prove the Importance of Chromosomes."

Journal of Heredity Vol. 10 No. 9 pp. 423-425.

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF THE HISTORY OF ARTS
AND ARCHITECTURE

CHICAGO, ILLINOIS

THE UNIVERSITY OF CHICAGO PRESS
54 EAST LAKE STREET
CHICAGO, ILLINOIS 60601-3043

TEL: 773-936-3700 FAX: 773-936-3701

INTERNET: <http://www.press.uchicago.edu>
E-MAIL: orderdept@uchicago.edu

UNIVERSITY OF CHICAGO PRESS

CHICAGO, ILLINOIS 60601-3043

BOSTON UNIVERSITY



1 1719 02553 0595

